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THE PRINCIPLES OF FLORICULTURE

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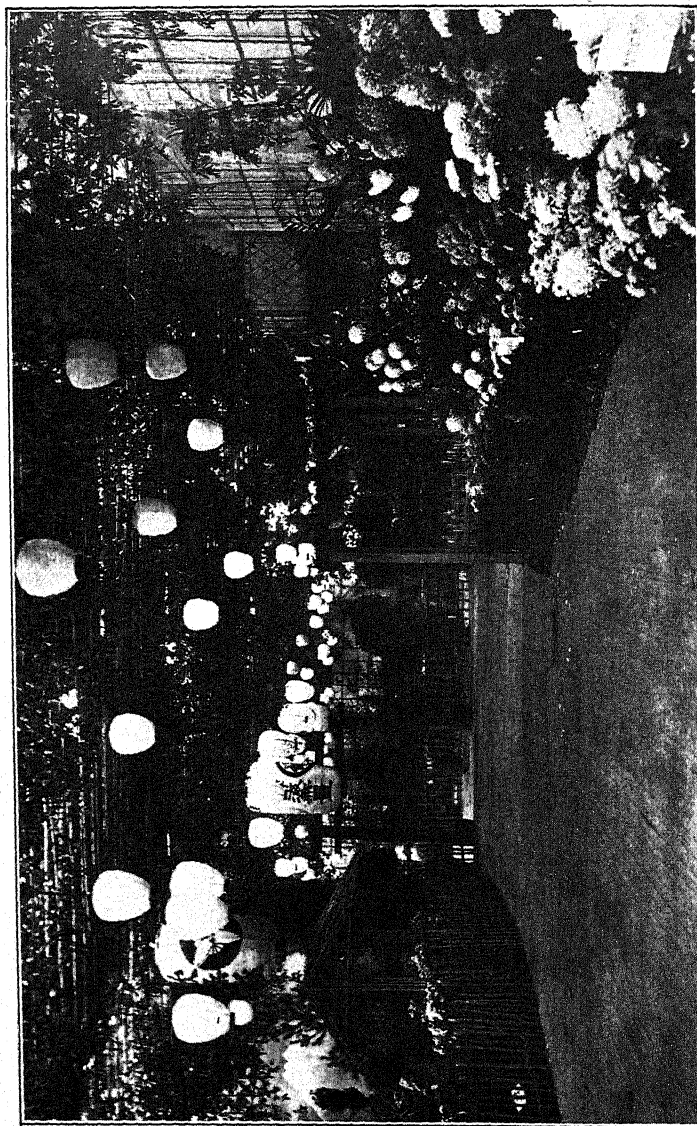
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Frontspace

A NATURAL AND ARTISTIC EXHIBITION OF CHRYSANTHEMUMS

THE PRINCIPLES OF FLORICULTURE

BY

EDWARD A. WHITE

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STATE COLLEGE OF AGRICULTURE AT
CORNELL UNIVERSITY

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PREFACE

INSTRUCTION in flower-growing has been given in American educational institutions for many years. Early in its history such instruction was a part of the curriculum of general horticulture, lectures in floriculture being given by those engaged in teaching other branches.

Within the last ten years there has been a breaking up of general horticultural instruction. Separate departments of pomology, market-gardening, and floriculture have been created, and each is supervised by one who devotes his entire time to his special subject.

Floricultural education, as a distinct and separate department, is, therefore, of comparatively recent origin. Because of this, there are few precedents, and the courses given have resulted from the experiences of comparatively few men. The material here presented has been compiled largely from the author's lectures. The book is, therefore, the outgrowth of experience and general observations. Branches of the subject which seemed unimportant, and methods of teaching which proved ineffective, have been eliminated, and only those phases retained which have appeared to meet the needs of students.

In the author's experience in teaching distinctly floricultural subjects, he has felt the need of a text-book. There are good books on special topics but no one work that treats of the general principles of flower-growing.

The purpose of the author has been, therefore, to consider the principles that underlie the successful culture of ornamental plants and to present them in such a way that the book may be useful in the classroom. It is also hoped that it may be of service in a useful way to practical men.

Illustrative material has been chosen largely from those subjects which the author has found to be helpful in his own work. It is expected that it will be supplemented by lantern slides and photographs illustrating the results of applications of the principles herein contained.

The author appreciates deeply the interest taken in this work by men engaged in various floricultural occupations and their hearty response to his requests for information regarding various details of the business. He is indebted also to his colleagues in Cornell University who have read the manuscript and have made suggestions for increasing its usefulness.

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April 1, 1915

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THE PRINCIPLES OF FLORICULTURE

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CHAPTER I

IMPORTANCE AND DEVELOPMENT OF THE FLOWER INDUSTRY IN THE UNITED STATES AND CANADA

FLORICULTURE is the art and business of growing and marketing flowers and ornamental plants commercially, and of growing them for home, park and cemetery embellishment. There are two distinct methods of culture, — under glass and in the open. The subject may be further divided into various phases, such as amateur floriculture, conservatory plant culture and commercial flower-growing.

1. Amateur floriculture — Amateur flower-growing interests probably the greater number of persons. Within recent years there has come to be a general interest in home ornamentation. People are seeking knowledge regarding the proper care of house plants and the selection of species and varieties of garden flowers for the home. The subject is a broad one and covers many interesting topics, such as plant propagation, the care of house plants, bulbs for indoor and outdoor planting, and garden flowers.

2. Conservatory plant culture. — The art of growing plants which have unusually attractive flowering habits or beautiful foliage is interesting a large number of Ameri-

can flower-lovers. The conservatory is designed more especially as a thing of beauty, to be kept filled with gorgeous blooms. The growing of plants for conservatories is largely done in houses of a different type, and many of the plants are changed frequently. A knowledge of the species of plants suitable for this purpose, their method of propagation, and also of their temperature and moisture requirements is essential for success in this branch of floriculture. This subject has a close connection with work on private estates, in parks and cemeteries.

3. Commercial floriculture. — Commercial floriculture deals especially with the culture and sale of plants and flowers for financial remuneration. Every year witnesses a greater demand for flowers by the buying public, and every year the number of men engaging in the business increases. This has resulted in keen competition and this competition has made it necessary for the flower-producer to utilize his greatest skill in the practice of the art, and to use also every scientific principle which will make his work more effective and his financial returns larger.

4. Methods of study of floriculture. — Constant association with plants gives the grower an intimate knowledge of their habits and requirements. Individual plants vary much as to their cultural demands, just as different crops vary in their temperature requirements. To give complete directions for the culture of plants grown by the amateur, for conservatory purposes or for commercial sale, is impossible. For general study, therefore, we consider only general principles. These principles may apply to the culture of plants or to the sale of florists' products.

5. Related sciences. — The art and business of growing plants successfully for commercial purposes is dependent upon several sciences. The business is rapidly becoming

a science in itself. In its early stages, commercial growers of flowering plants recognized the need of but few scientific principles. As competition has increased, however, there has come to be a strong feeling among flower-producers that a thorough knowledge of the soil and its fertilization, the principles governing plant growth, the principles of plant-breeding, also a knowledge of the various insects and diseases which attack plant tissue, is very essential for the successful culture of any crop.

To understand properly the soil and its fertility, a knowledge of chemistry and geology is necessary. Botany, or that phase of it which treats of the normal functions of the plant, known as plant physiology, is especially important. Plant pathology, which deals with plant diseases, is equally important. All plant-growers should have a knowledge of entomology that they may understand the structure and habits of insects and thus be prepared to combat successfully their attacks. Combined with a knowledge of these subjects, commercial flower-producers should have keen business ability, so that the cost of production may not exceed the financial returns.

6 Origin of the commercial flower-growing industry.

—The early history of the flower-growing industry is obscure. It was merged to such an extent with other branches of horticulture, and other industries, that for a considerable period it could hardly be called a distinct industry. It is supposed to have originated in the early part of the nineteenth century, in the vicinity of Philadelphia, which was at that time foremost in the social life of the United States. The sale of cut-flowers, however, was of very little importance at that time, and the few flowers sold were largely placed on the market by seedsmen, or grocery and provision dealers.

7. Importance of the industry. — Flower-production is becoming more and more an important factor in the business world. In the early history of the United States, people were so busily engaged in establishing homes and various branches of other commercial industries, that little attention was given to the more æsthetic features of life. Flowers have, however, always played an important part in the social life of the people and been a cheering factor in bereavement. Within recent years they have been more and more in demand, especially in large cities and towns where there are many social functions, and at holiday seasons. This has given flower-production a wonderful stimulus.

8. The growth of the industry. — Between 1830 and 1840, rapid progress was made in plant-production. The demand for greenhouse products increased to a considerable degree. Better greenhouses were built, better systems of heating were devised, and consequently better products were put on the market. Previous to 1870 the flower-growing business consisted principally of plants for out-door bedding and for other ornamental purposes. The cut-flowers of that period were mostly small-flowered and short-stemmed, such as heliotrope, camellia, tuberose and bouvardia. Although the carnation was introduced as a florist crop about 1852, it was of little commercial importance previous to 1870. About 1865, the firm of Dailedouze & Zellar of Flatbush, Long Island, began to breed the carnation, and between 1866 and 1872, they introduced several new varieties.

Garden roses had been popular for many years, still few attempts were made to grow them under glass previous to 1870. Following that date, roses so grown came rapidly into public favor. Commercial orchid, violet

and sweet pea culture under glass was at that date unheard of. From 1870 to 1880, the demand for both potted plants and cut-flowers increased rapidly. More attention was paid to city and town ornamentation, therefore more greenhouses were built. Each year witnessed improvements in construction and consequently better grades of florists' products.

STATISTICS FROM UNITED STATES CENSUS OF 1910

The floricultural statistics taken from the census of 1910 show a marked increase in the importance of this branch of agriculture as compared with the statistics of 1900. There is not only an increase in the number of establishments, but what is more striking, there is an increase in the valuation of the establishments. This means that the business has been highly remunerative, and as a result, ranges have been built. The following quotation from Volume V, United States Census of 1910, is full of valuable information regarding the importance of the flower-growing industry in the United States:

"The total number of farms and florists' establishments reported their production of flowers and plants in 1910 as 10,614; the total acreage reported as devoted to these products was 18,248; and their value was \$34,467,440. This was an increase of 85 per cent as compared with the census of 1900. The acreage of flowers and plants increased 96.1 per cent between 1900 and 1910.

"About 99 per cent of the value of flowers and plants in 1910 was produced in 7444 establishments, that had an output valued at more than \$250, the average valuation of these establishments being \$4630. As would be expected, a large part of these establishments were located

GEOGRAPHICAL DISTRIBUTION OF GREENHOUSES IN THE UNITED STATES — *continued*

Division or State.	Flowers' Establishments Reporting \$250 or over, 1910			Area of Land under Glass (Square Feet) 1910		
	Number	Total value	Average per establishment	Total	Covered by greenhouses	Covered by sashes and frames
<i>South Atlantic — continued</i>						
North Carolina	32	121,367	3,793	193,139	176,853	16,286
South Carolina	12	51,536	4,295	74,318	66,242	8,076
Georgia	37	262,720	7,101	867,222	741,672	125,550
Florida	29	66,650	2,298	711,787	568,190	143,597
<i>East South Central</i>						
Kentucky	100	355,780	3,558	1,363,002	1,276,823	86,179
Tennessee	42	338,879	8,069	1,236,874	1,079,374	157,500
Alabama	31	167,399	5,400	463,575	435,400	28,175
Mississippi	23	97,751	4,250	216,937	201,622	15,315
<i>West South Central</i>						
Arkansas	17	151,811	8,930	235,134	224,150	10,984
Louisiana	54	122,289	2,265	347,473	260,711	86,762
Oklahoma	31	91,077	2,938	158,515	148,737	9,778
Texas	92	466,820	5,074	986,070	907,615	78,455

<i>Mountain</i>						
Montana	17	104,192	6,129	308,939	289,024	19,915
Idaho	10	42,497	4,250	59,477	58,727	750
Wyoming	3	12,020	4,007	33,034	31,584	1,450
Colorado	73	464,141	6,358	1,340,824	1,244,425	96,399
New Mexico	8	30,720	3,840	87,054	59,752	27,302
Arizona	5	10,977	2,195	29,810	26,730	3,080
Utah	25	79,914	3,197	261,292	249,280	12,012
Nevada	1	1,600	1,600	4,600	4,600	
<i>Pacific</i>						
Washington	119	512,350	4,305	1,539,972	1,257,616	282,356
Oregon	72	236,187	3,280	716,543	672,207	44,336
California	347	1,373,577	3,958	5,037,132	4,422,423	614,709

near large cities. The leading states in value of flowers and plants were New York, with \$5,110,221; Pennsylvania, with \$3,760,644; Illinois, \$3,680,973; New Jersey, with \$2,839,319; and Massachusetts, with \$2,432,000. The total area of land under glass in 1909 was reported as 114,655,276 square feet, of which 105,165,730 square feet were in greenhouses, and 9,489,546 square feet were covered by sashes and frames.

STATISTICS FROM CANADA

The floricultural statistics for the Dominion of Canada are less complete than for the United States:

Capital invested approximately	\$1,500,000
Square feet of glass	6,000,000
Annual output	1,800,000
Area covered — 120 acres	

IMPROVEMENT IN FLOWER CROPS

Among the factors which have done much to improve the quality of florists' products are the following plant-breeding; the establishment of retail stores, wholesale commission houses and coöperative flower markets; the tendency of flower-growers towards specialization; the demand by the buying public for a better quality and for new species or varieties; and the frequent floral exhibitions which have been held in the larger cities and towns.

9. Influence of plant-breeding. — Beneficial effects of the work of the plant-breeders began to be seen in the early part of the decade from 1890 to 1900. Some work had been done before this, but it was unsystematized and there were few definite results. Many new varieties of carnations and chrysanthemums began to appear on the

market, but no marked results were observed until early in the twentieth century. Breeding and improved cultural methods then brought the quality of the products far above anything which had previously been produced. Large-flowered carnations on long, stiff stems, violets of larger sizes, improved strains of chrysanthemums and other species of greenhouse flowers gave a remarkable impetus to the industry.

10. Establishment of flower markets.— Previous to the beginning of the twentieth century, the American florist interested himself in the culture of a wide variety of plants. In many cases the larger part of the products were sold at the range. The business, however, assumed such proportions that many up-to-date florists found that they could not profitably raise and dispose of their products at retail. Too much of the grower's time was spent in waiting on customers, and the quality of his products often suffered as a consequence. Soon wholesale commission houses and cooperative flower-markets were established in the larger cities and towns. These supplied the retail stores with fresh flowers every morning. By this method of disposing of his products, the flower-grower was able to devote nearly his entire day to cultural practices in the range; and by cutting his flowers, or packing them for shipment in the late afternoon, they were in the market in the early morning, in excellent condition.

11. Specialization.— In the latter part of the nineteenth century, many of the more progressive florists decided that they could not afford to grow a wide variety of plant-species. It was more profitable to grow one or two crops and to devote their whole attention to approach perfection if possible. Hence it was that men came to be known as carnation, rose, violet, chrysanthemum, fern,

and palm specialists. This led to a wonderful improvement in the quality of flowers produced, and there is little call in the market for inferior grades. Many large American flower-producers are managing their business on a departmental scale. There are wholesale and retail departments, — palm, carnation, orchid, rose, chrysanthemum and bedding plant departments, — each in charge of a specialist in growing that particular crop.

12. Demand for better quality in flowers and plants; also for novelties. — The buying-public has had its influence in producing a better quality of florists' products. It demanded not alone a better quality, but something out of the ordinary as well. People tired of roses, carnations, violets and bulbous-stock continually. The early part of the twentieth century witnessed a remarkable interest in orchids. The commercial man had to meet the demand for these flowers. Twelve years ago an orchid was rarely seen outside private or park conservatories. It was considered impossible to grow them with financial success. To-day nearly every up-to-date retail-grower has his section of orchids, and every large, floricultural center, its orchid specialist. Likewise for years it was considered impossible to secure satisfactory results from sweet peas under glass. The growth was weak, there were few flowers, and they were usually short-stemmed. The introduction of new strains and the careful study of cultural conditions has made this crop an important one to the florist and one which is immensely popular with the buying public. The forcing of hardy, herbaceous perennials, antirrhinums and delphiniums for examples, also the forcing of hardy shrubs and other rarer stock, has furnished the flower-grower with a wonderful range of the more unusual plants.

13. Flower exhibitions.—The flower exhibitions (frontispiece) which are held from time to time in the larger cities, have had a beneficial effect on the uplift of the business. These exhibitions have been viewed by thousands of flower-buyers. The choicest products of the flower-grower's skill have been exhibited, and the public has become dissatisfied with inferior grades. They demand a better quality such as they have seen at exhibitions, and it has been the work of the commercial grower to produce such qualities.

All these factors have had a marked effect in improving the quality of flowers and plants offered for sale in American flower stores. Nevertheless there is still room for improvement. In too many sections, the watchword of the grower has been quantity instead of quality. Plant-breeders and investigators of better cultural methods will find investigations regarding plants adapted for greenhouse forcing, a most fertile field in which to work. By means of the methods used and the results obtained by investigations, it will be possible to produce a wider range of species adapted for forcing under glass, and an amelioration of those species already under cultivation, so that marked improvement will constantly be noted in all florists' crops.

CHAPTER II

CENTERS OF THE INDUSTRY AND THE MARKETS

SINCE the establishment of the flower-growing business, it has centered about the more thickly populated sections. As land values have increased rapidly, there has been a movement on the part of some growers towards the less populated areas. The amount of land required for greenhouses of the average size, and that necessary for the general work of the range is not large, however, and the perishable character of the products has resulted generally in the locating of many medium sized ranges in suburban sections.

LOCALIZED CROP PRODUCTION

In view of the fact that certain soils and climatic conditions favor the growth of special crops, the character of plants grown in certain sections has localized the production of species. For example, the largest violet-producing section in the United States is in Rhinebeck on the Hudson and its immediate vicinity. Carnation culture centers about southern New England and Long Island, although that crop is less distinctly centered than is the violet, because of the carnation's ability to adapt itself to a wide variety of soils. The American Beauty rose requires an abundance of sunshine in which to develop a luxuriant foliage and brilliant coloration, therefore that crop is

largely grown in southern New York, New Jersey, eastern Pennsylvania and in the vicinity of Chicago. In a similar manner, orchid culture has centered around northern New Jersey, not due in this case to soil or climate, but because orchid specialists have happened to locate there. The suburbs of Chicago have become large flower-growing sections where are found some of the largest ranges in the world. Chicago is now one of the greatest flower distributing centers in the United States.

Greenhouses for the culture of flowers are becoming more and more in demand in the south and west, while in many sections climatic conditions are such that cut-flowers may be grown out-of-doors; still the perfection of blooms, due to the better cultural conditions made possible under glass, and the consequent increased financial returns, have encouraged growers to erect glass structures.

THE MARKETS

Flower markets are of three principal types: retail stores (paragraphs 14-22), commission houses (paragraphs 23-24), and cooperative markets (paragraphs 25-29).

14. Retail stores, their beginnings. — The exact date of the establishment of retail stores for the exclusive sale of cut-flowers and potted-plants is unknown. History tells us that this industry had its beginning in Philadelphia and New York in the early part of the nineteenth century. It is said to have started in connection with grocery stores, when merchants put potted plants in their windows for decorative purposes. This led to a demand for these plants by the customers, and later a demand for seeds from which the plants were grown. Eventually the plant

and cut-flower industry became highly specialized until at the present time flower shops are to be found in every large city and town in the United States.

15 Character of the retail store and its location. — In the larger cities and towns competition has brought about a wonderful development in these stores. For the most part they are centrally located, for as flowers are not a necessity, they must appeal to the people through the beauty of their display. Therefore, flower stores are located principally in busy sections of industry, where people are constantly passing. If the section is an aristocratic one where wealthy patrons congregate, the location is considered more ideal.

The more desirable locations naturally necessitate a high expenditure for rent; however, it is not economy to locate a flower store on a side street where rents are lower, unless the firm be an old one which has established a reputation and has a set of clients who will continue to patronize it even if somewhat isolated.

A more common use of the telephone has increased the number of orders for flowers, but when possible, the buying public prefers personally to select flowers, rather than to leave the selection to another.

One of the most prominent retail men in America says: "The location of a flower shop is in itself one of the most prominent features when advertising is considered. Some firms pay a monthly rental of from one to five hundred dollars a year in excess of what would actually be necessary in the way of space and convenience, that they may reach the public from an advertising viewpoint. Window space in the higher rental districts of the country is certainly a live advertising problem. This feature is more often neglected than is the copy sent to a newspaper

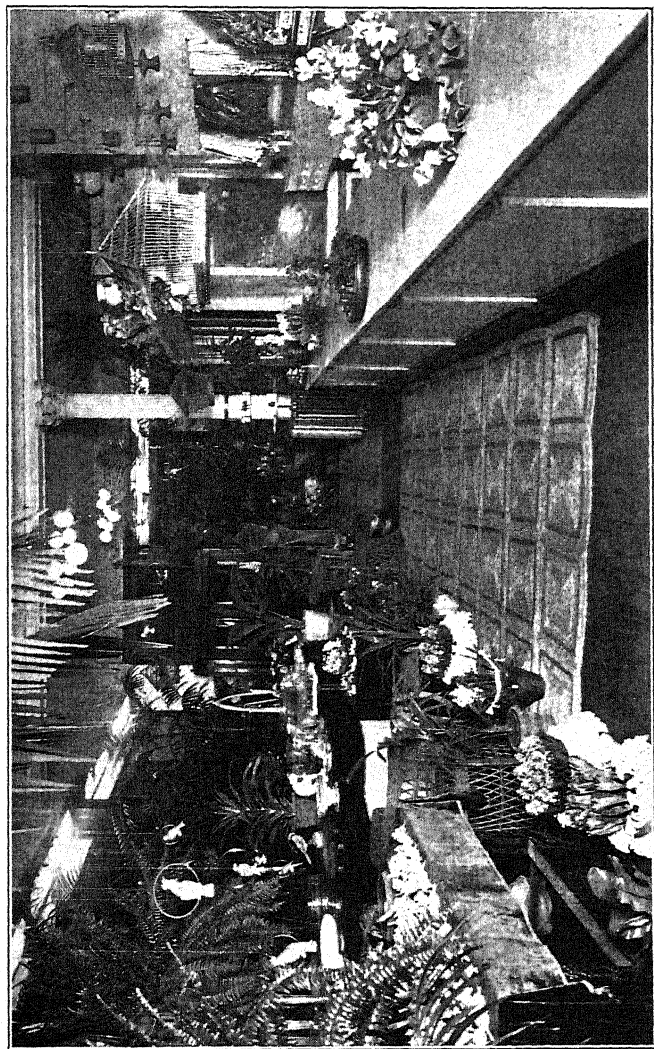


FIG. 1.—A well-arranged, and attractively decorated retail store.

in general distribution. Advertising space in a prominently located shop window may be reckoned with by the fraction of an hour."

Next to location, it is highly desirable that a flower shop have artistic and attractive interior fittings (Fig. 1). The business should be made to appeal to the æsthetic tastes of the people. It is therefore essential that the decorations harmonize in every particular with the color of the plants and flowers which are to be put on sale. Nothing presents a richer appearance than white enamel paint. Soft, rich shades of green for decoration, such as are found in the foliage of plants, may also be used. Other tints should be avoided, for as a rule they have a tendency to cheapen the effectiveness of the interior. There should be a liberal use of mirrors, for they not only increase the appearance of size and richness of the interior, but they often double the apparent quantity of the stock of flowers and plants.

16. Character of the retail stock. — The stock should always be fresh, and the foliage of palms and other potted plants should be clean. A retail store should be liberally stocked with all flowers and plants liable to be in demand, or they should be quickly available when ordered. There should be a full equipment of vases, baskets, ribbons and other accessories which are necessary for first class trade. The ice box should be attractive and well kept. Nothing detracts more from the up-keep of a store than an ice box of fading flowers, or a window full of fallen petals. Neatness and order are essential factors in every successful retail store (Fig. 2, lower).

17. Methods of management of retail stores. — Success in selling flowers at retail depends in a considerable measure on the personality and the business ability of those in

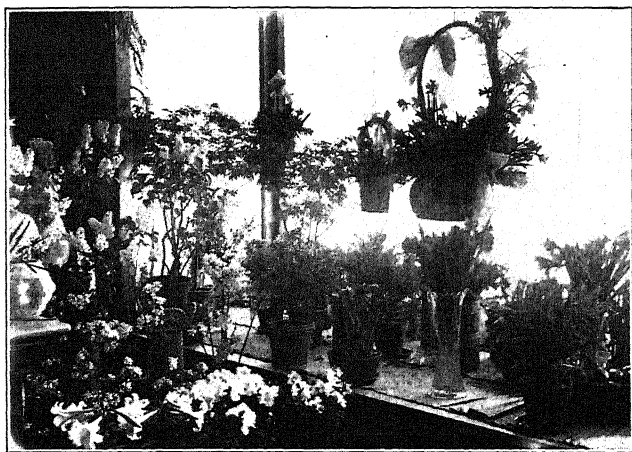


FIG. 2.— Upper. Window displays are the best means of advertising a retailer can use. Lower. Neatness and order are essential factors in every successful retail store.

charge. If clerks are interested and enthusiastic in their work, and manifest an endeavor to please customers, all this affects very materially the developing and maintaining of a profitable business. If clerks have a knowledge of plant requirements they can often be of service to customers in advising regarding the choice of material for certain conditions.

Every large, well-organized flower shop has its separate departments of work. Aside from the sellers of flowers and plants, there should be at least one clerk who is well versed in buying and he should keep in close touch with wholesale flower concerns. There should be one or two clerks well trained in making artistic designs and bouquets. Others should understand interior decorating and be especially expert in table decorations and work of a similar nature. It is rarely that one finds in a single clerk the ability to perform all of these branches of work in an acceptable manner.

Store window displays are, without doubt, the best means of advertising a retailer can use (Fig. 2, upper). It is, however, the opinion of men engaged in the business that most flower stores, particularly in large cities, will have to resort to daily newspaper advertising. Among retailers who have made a pronounced success through this medium of advertising are Penn of Boston and Fleischman of Chicago. This is a more common practice in western cities than in the east. To move stock quickly, especially when the markets are dull, newspaper advertising is one of the ways every live florist will have to pursue and not depend altogether upon his window and his own personal efforts to please his customers. These of course are important points, but the florist does not want to depend altogether on one thing to

bring him customers. In these times of keen competition, every legitimate method should be followed. There is an opening for a man alive to his opportunities, in every large city, and the florist who places his goods before the public in an attractive manner through the medium of advertising is sure to succeed. One florist has worked up a big trade on the "dollar box," mainly through street-car advertising. As a rule, street-car advertising is not as productive of results as newspaper advertising. Still it is of value.

Any good method of advertising that is commenced should be followed systematically and regularly, and not be done in a spasmodic or indifferent way.

Credit is a matter which cannot be watched too carefully. Loose credit ruins many business establishments. It has been stated that half the success of every man's business is in his collections. They should be watched carefully. A bill is collected more easily when it becomes due than when allowed to become overdue.

Irwin Bertermann of the firm of Bertermann Brothers Company of Indianapolis, Indiana, discusses the retail business as follows. "It is essential that a retail flower shop be properly piloted through the office, but it is equally important that there be an efficient store manager. It requires the personal oversight of one person to see that designs are properly filled with flowers; that material is not used unfairly with relation to customer or to firm, that elegant and attractive windows are maintained, that all buying is on a proper basis, and that promptness and cleanliness are prominent in the maintenance of the store.

"The head of one retail firm expresses the management in this way: 'It takes a General in thought and action properly to head a force of men in a workshop, particularly

when individuality and artistic qualities are considered essential.'

"Solid business principles must be adopted in every retail flower-shop."

18. Selling flowers and plants at retail. — "Every well-organized store has a definite and well-organized method of recording sales. They are usually placed on sheets in tablet form, with time of delivery and a notation for remarks printed on the same. These sale slips are distributed in wire baskets arranged for the days of the week. Upon filling the order, the clerk files this slip as a charge or paid order. Upon being transferred to the office, these slips are immediately transferred to a duplicate bill by the aid of carbon, and the originals are filed for the mailing period at the end of the month. The duplicate is retained on file and is always available in case of an inquiry by patrons. This also saves the bookkeeper the time required for making itemized statements on the ledger.

"A sale-slip should indicate the clerk taking the order, also the one filling the same. It indicates clearly to the office at all times what each clerk is doing in the way of efficiency, the amount of his sales and the prices received."

19. Advertising for retail sales. — "Advertising is an important feature of all retail work. This has grown with greater strides in the retail flower business than in almost any other phase of retail work. Indirect advertising, such as good service, fresh flowers, artistic designs and bouquets and promptness in delivery, is the foundation on which all successful flower firms are built. It is useless to waste printer's ink without these basic elements. The next surest method of reaching the thousands of flower lovers is to take space in the most prominent newspapers. This is

expensive, and the direct returns nearly always fall short of the amount expended for space. The indirect returns, however, are very far reaching and may often be accounted for many months after the advertisement has appeared.

“In this age of automobiles, much advertising is obtained through them. When attractively painted, their passage through prominent thoroughfares brings a firm into prominent notice. Theater programs, moving picture screens, street-car advertising and many hundreds of other forms may be secondary influences in obtaining the attention of the public.”

20. Retail delivery. — “Delivery is another prominent feature of retail work. Efficient and inexpensive delivery is one of the great problems of the dealer in flowers. Unlike most other kinds of business, the florist is expected to cover the town in a stated time period. He deals with weddings, funerals and other important events in life which demand prompt attention. This can be maintained only at great expense. Roomy, luxurious automobiles are a great convenience and are much noticed by the public, but they are an expensive proposition, and without doubt these will later be replaced by a smaller and more practical type of vehicle. It is considered that an automobile operated at an expense of one cent a mile is vastly different from one operated at an expense of from eight to ten cents a mile.

“In an average town of from two to five hundred thousand population, there should be a minimum price on which articles should be delivered. Very little profit is made on an article sent that was purchased for less than one dollar.

“On large delivery routes, horses are now considered out of the question in the delivery field, and it behooves

the retail flower grower to discriminate accurately when selecting a motor-propelled vehicle."

21. Retail office methods. — "For most firms maintaining a retail and a growing establishment, the method of enclosing a voucher is of inestimable value. As with the billing, there is a duplicate system maintained throughout. One of the forms is sent out with the goods and the other is kept on file alphabetically, thus giving the office an accurate insight at all times in regard to the various branches of the business. A monthly report with the segregated items as named on the face of the voucher will give any manager or owner an accurate idea as to where improvement may be made, where expenses may be properly increased and where they should be curtailed. A comparison with the receipts at various times will show clearly whether the selling department is properly digesting the flowers received from the growing establishment. In other words, the cost of the flowers may be arrived at by a method of elimination and comparison with the expenses of growing the stock and the gross receipts of the business.

"Various firms have at times maintained that it was possible to judge accurately the value of the stock received from the growing establishment. In the opinion of the writer it is absolutely impossible to do this because of so many changing market conditions, for when a flower is sold at one cent in the morning and at two cents in the afternoon, it is difficult to set an accurate price. It is far better to keep a proper cost system of all materials used and of labor necessary at the greenhouse, and by comparison with the store receipts, arrive at a proper estimate of the income and outgo of both range and store."

22. Retail credit systems. — "There is a wide difference in cities and towns in regard to credit systems. For-

tunately most large cities possess good credit bureaus which have made the life of those endeavoring to obtain false credit, a very unsatisfactory one. The loss from poor accounts in an average well-managed flower shop should be exceedingly small; in fact, it should be less than one half of one per cent. Salesmen should at no time be permitted to give credit to anyone without particular permission from the manager or office unless the parties be steady customers and well known. The bookkeeper naturally has the most available information regarding credits and he passes judgment as to whether or not charges are permissible. His instructions are to permit no one, the manager excepted, to give credit to anyone whose business dealings are at all questionable. This leaves but a small fraction of one per cent to be lost in a year's business. It also prevents a vast amount of work in the office, mailing bills to slow customers, and eliminates long periods of watching and waiting by the collection department.

"It is certainly wisdom to keep undesirable parties off the books, and it is equally advisable not to enter into any controversies with them regarding payment. Prompt collections are essential, but nothing is gained in quarreling with the buying public.

"A good business system is to mail the bills the first and second months. They are then given into the hands of a collector for the two succeeding months. This is followed by a courteous letter requesting immediate payment, and then a stronger letter is sent. If checks are not then forthcoming, the bills are turned over to an attorney for whatever action he may advise."

23. Commission houses, history of. — Commission houses are established in nearly all large cities, for the

purpose of supplying the retail store with the produce grown in greenhouses. Thus these function as a medium between the producer and the seller.

The business of selling florists' supplies to retail stores developed in New York City about 1870, when James Hart founded the pioneer wholesale establishment. In 1877, Patrick Welch, now president of the Welch Brothers Company, started the house in Boston. Since that time, wholesale houses have developed in many cities in the United States.

To secure all the information possible regarding the wholesale business in various sections of the United States, letters were sent to many commission men and much valuable information was obtained. The historical review by Patrick Welch of Boston was especially valuable. Mr. Welch writes as follows: "The wholesale dealer in cut-flowers, the middleman, or the commission man, as he is sometimes called, came into favor with growers of cut-flowers during the latter part of the nineteenth century. Many growers then found it inconvenient if not unprofitable to sell their own products.

"In Boston, the pioneer house of Welch Brothers opened on October 10, 1877. When this firm started to sell flowers on commission, the outlook for a big business was not very encouraging. For several years, the founder had to be content with the products of two small growers. As the business advanced, however, new and larger greenhouses were built, and many men who had been engaged as private gardeners took up commercial work. There then came to be a greater demand for a means by which the products from these ranges might be turned into money, and the wholesale business became quite an important branch of the flower industry. It is to-day the principal

medium of transfer of the products from the producer to the retail dealers.

"Welch Brothers built up a very extensive business by shipping flowers to various centers throughout the country. Chicago purchased from Boston between the years 1870 and 1885. Cleveland, Buffalo, Detroit and Montreal were large buyers from this center in the early days. As the products of flowers increased in the vicinity of these cities, purchasing from the east grew less, thereby forcing the growers near Boston to dispose of their products in the New England markets. As orders for shipping flowers to the west decreased, there was a natural increase in local demand, so much so, that to-day in Boston as in New York, a large percentage of the products handled by commission men is consumed in the home market."

In discussing the wholesale business in Philadelphia, S. S. Pennock, of the firm of S. S. Pennock-Meehan Company, states as follows: "The commission end of the business has probably advanced as much or more than any branch of the flower-growing industry. The grower of to-day would not be where he is, if it were not for the commission house. These houses have backed him in many cases, in fact, helped him in many ways. They have encouraged him to build greenhouses, and found the market for his product. The commission-man and the grower cannot be too closely together, and every move for advancement should be made for their mutual benefit. When we started in business, we were shipping roses to Chicago, St. Louis, and often as far as Minneapolis and St. Paul, with very good results. Now there are very few shipments that go as far west as these cities. Shipping trade will probably grow less from the large centers, excepting in new territory where there are towns building up,

as each town will eventually have its own greenhouse establishments.

"In the early seventies when my father, Abraham L. Pennock, was in the retail end of the business in the firm of Pennock Brothers, I have heard him say that during the Centennial Year, 1876, he would go on to Boston and buy all the roses he could find. He said a relative from near Boston went into that city at one time and wanted to get some roses for a wedding. He was told that there were no roses to be had, for Mr Pennock had come from Philadelphia and bought all there were in the city. It is not a great many years to look back that far and yet think of the changes. No man now could buy all the roses that come into Boston or any other city in the East.

"The commission houses in the country are inaugurating a better system of bookkeeping. Formerly accounts were kept in a very slipshod way. A few firms still neglect this important factor and their returns to growers are more or less a matter of 'guess.' The larger and more up-to-date houses, however, have a systematic way of keeping a record of everything that comes into and goes out of the store, otherwise they could not make honest returns to their growers. The best commission houses do a straight business and return to the grower exactly what they get for their stock. Nothing is guessed at. As a general thing, the commission on cut-flowers is too low. If it were not for the other things which wholesalers handle, the balance sheet at the end of the year would never be on the right side. The expense of handling cut-flowers seems to increase every year. Commission men have to give more service and do more for the retailer each year. This probably is, in part, the fault of the commission man himself, but competition has driven him to this."

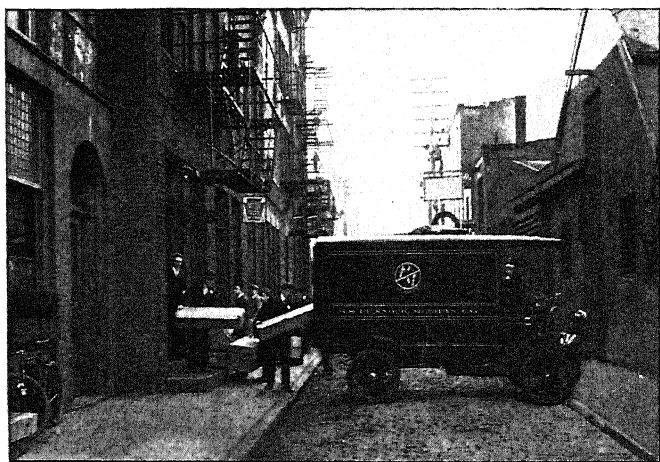
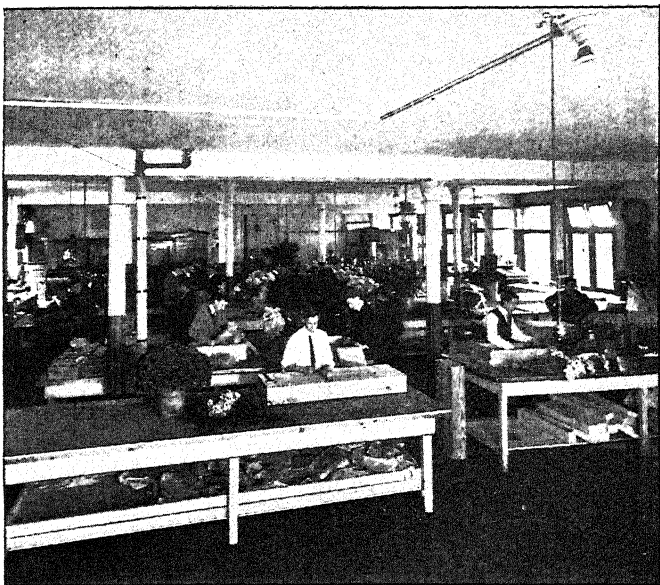


FIG. 3.— Upper. Interior of a wholesale commission store. Lower. Exterior of a wholesale commission store with delivery truck.

24. Methods of commission house management.— (Fig. 3.) The organization of the working staff in commission houses is not unlike that of the retail store. Aside from the office staff there is usually a manager who has general oversight over all employees. Clerks with artistic abilities, such as the retail store demands, are not an absolute necessity but they must be well trained in packing and unpacking plants and cut-flowers, so that the work may be done quickly and the products reach their destination in excellent condition. Most wholesale firms have a traveling representative who takes orders for ribbons, material for designs, vases and other florists' supplies.

Each wholesale house has a definite system of management. As a rule, wholesale men arrange with the growers to handle their out-put strictly on a commission basis. This commission is generally fifteen per cent on the gross sales. Within the last few years, the co-operation between growers and commission men has advanced to such an extent, that many growers consult with the commission men as to the flowers required to meet the market demands.

In addition to the agreement which the wholesaler makes with the grower to take his produce, the wholesaler must also purchase certain goods at net prices, that he may be prepared to meet the requirements of his patrons at certain seasons. This is particularly true at Christmas, Easter and during Memorial Day week. It is not unusual for one house to engage at net prices, fifty thousand roses or one hundred thousand carnations with a proportionate supply of other goods, all in addition to the products of the regular growers.

Most wholesale houses have a system whereby a grower, when he consigns to a wholesaler, is given a num-

ber. All goods are sold under that number and it is credited with the amount of the sales. Each week a report of the goods sold is made to the grower. Once a month a check is made payable to the grower for all sales, less the commission and express charges. Unless special arrangements are otherwise made, the growers pay for transportation. The commission man bears a heavy expense in providing clerks, rent, heat, light and cold storage. As he must stand all losses on accounts, it is considered that the actual profit on commissions is from two to five per cent. Some wholesale dealers assert that if it were not for the fact that they handled other material than cut-flowers, they could not do a profitable commission business.

In connection with the wholesale business in Chicago, the firm of E. C. Amling Company states: "Mr. E. C. Amling started business in this city about nineteen years ago by selling cut-flowers to the trade on fifteen per cent commission. During this period the business has increased so that our sales are nearly one-half million dollars a year. The firm was incorporated four years ago. We handle only cut-flowers and they are sold at the highest price obtainable according to supply and demand. We send our shippers, of which we have about sixty-five, a check each week for the total sales less commission and express charges. With this check we send a report sheet. We have no contract with our growers. Our only inducement is the highest price to be had on our market for the season, which is sure to be a profitable one for the grower provided his stock is up to the standard or better. Goods shipped to our customers are at their own risk after the express company has signed for same. We cover the territory from Pittsburgh west to Omaha and

from Winnipeg, Canada to New Orleans and Jacksonville. All the stock to these long-distance points is heavily iced. The only inducement given our customers is the right kind of goods and service, which means our sales are strictly sales of service. Chicago has a population of two and one-half million people. We have about five hundred retail flower stores and twenty-four wholesale houses. Some of these wholesale houses, however, have their own greenhouse establishments and sell only their own stock. There have been several co-operative flower markets established here, but they have never been successful."

In a report from Pittsburgh, Pennsylvania, the McCallum Company states: "Pittsburgh has a population of about 800,000 and including the adjoining suburbs, 1,200,000. There are but two wholesale establishments and about thirty retail stores."

E. G. Gillett reports for Cincinnati, Ohio, a population of about 500,000 with fifty retail stores and nine wholesale houses.

25. General management of co-operative flower markets. — Co-operative markets have been established in a few of the larger cities. Some have been successful and some have not. The general management of flower markets is similar. They are managed by a board of directors, who are elected annually by the stall renters. One of the oldest and most prosperous co-operative flower markets in the United States was organized in Boston in 1892, with sixty stalls. This was incorporated in 1909. At the present time there are one hundred and seventy-four growers bringing produce to this market.

26. The stalls and their rental. — (Fig. 4.) To rent a stall, one must be an owner of a greenhouse. No stalls

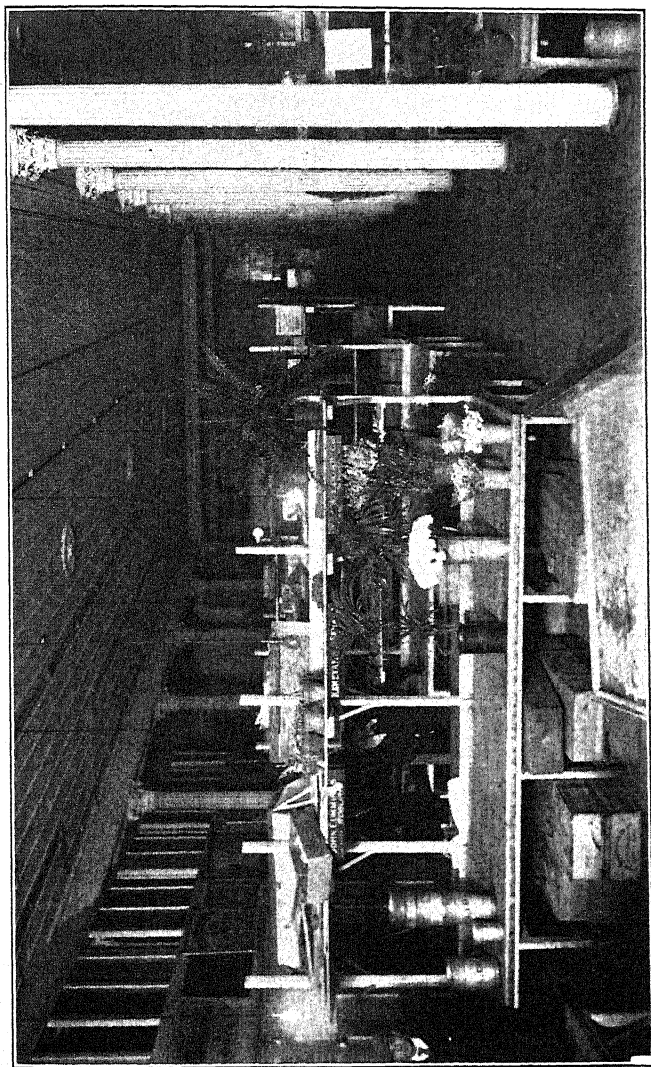


FIG. 4.—Interior of a co-operative flower market, showing arrangement of stalls.

are rented to other dealers in plant products. Each stall covers approximately fifteen square feet of floor space. There is a good counter three and one-half feet wide and nearly four feet long. Here is made the principal display of products. Above this is a smaller shelf, and below is space for storage of boxes. The stalls rent for from fifty-five to one hundred dollars a year, according to location. The rent of a stall includes light, telephone service, vases, ice and such space in ice boxes as may be required. The stalls are auctioned for the year each fall, and the most desirable ones go to the highest bidders. There are some objections to this method, one being that most growers prefer to occupy their stalls successive years, so that buyers will always know where to locate them. A change is proposed whereby all stalls will be divided into sections. The most desirable will be classed in Section A, the next in Section B, and so down to the least desirable. The rent for each section is made uniform, and a renter may keep his stall indefinitely if he so wishes. A grower may also rent several stalls if his business demands it.

27. Rules governing renters of stalls.— There are general rules governing the conduct of renters of stalls and they must agree to conform to the rules of the corporation. The regular market hours are from six to ten every morning, but salesmen are on duty until five in the afternoon, and no salesman or lessee is allowed to leave the immediate vicinity of his stall to solicit customers, neither is he allowed to solicit or accept retail orders within the market. There are also general rules governing the conduct of the lessee or his salesman during market hours. Any complaint against a lessee or salesman as to the manner of conducting his business, or the breaking of rules of

the market, is investigated by the board of directors, and such salesman may be denied the privileges of the market if, in their opinion, such action is thought best.

28. The manager of the co-operative market and his duties. — The general market is directly governed by a manager and an assistant manager. It is the duty of the manager to see that all rules governing the conduct of stall renters are obeyed. He has general supervision over the up-keep of the market, assigns such space in cold storage as may be necessary for keeping surplus flowers, receives all telephone calls, which he transmits to stall renters, and collects all rents as they become due.

29. Area from which shipments are received. — Most flower-growers who rent stalls in co-operative markets live comparatively near the city. They, or their salesmen, travel to the city on early morning trains, returning to the range late in the forenoon. This gives an opportunity to work about the range in the afternoon. Some growers, however, live at a considerable distance from the market and the produce is shipped to salesmen. This is often received in the late afternoon, and the flowers are for sale the next morning. With many growers, the flower market is a popular method of disposing of their products. It eliminates the middle-man, so-called, and lowers the cost of selling. Being co-operative, annual dividends are declared by the directors. A certain percentage of the annual profits are withheld for a reserve fund. This covers any deficit which may result from lighter rental of stalls one year over that of another.

CHAPTER III

FACTORS THAT INFLUENCE THE SELECTION OF A LOCATION

BEFORE building a range of greenhouses for commercial flower- and plant-production, there are problems which enter into the desirability of the location which should be carefully solved. A study of these is equally important if one is about to purchase an established range.

30. The market. — In deciding on a location, much will depend on the method of marketing. Products may be sold at retail at the range; they may be delivered at retail stores in a near-by city; sold personally in co-operative flower markets, or disposed of entirely in wholesale markets. If one is to do a retail business at the range, it is evident that the location should be one easily reached by the buying public. It should be within easy walking distance of the center of the town or, better still, on the line or at a junction of a much-traveled trolley system. If products are to be delivered at retail stores, the range should be within easy driving distance or on an electric line which runs express cars thereto. If such locations as mentioned are not available, the houses should at least be on a steam railroad which runs frequent trains to the business center. It is almost an absolute necessity that transportation to retail stores be rapid. Frequently large orders for flowers are received unexpectedly, and it becomes necessary for the retail man to get them almost

immediately from the range. If flowers grown are to be sold personally in co-operative flower-markets, again the range should be accessible to rapid transportation, and especially on a line where early morning trains to the town are available. The grower must often start for these markets very early in the morning, for the major part of buying and selling is done before seven o'clock. Should the plan be to sell all products at wholesale and to ship them by express to city stores, distances from these markets are less important. The range should, however, be on a line of railroad which has several daily express trains to some large business center, and if several of these centers are available, the added market facilities make such a location all the more desirable.

31. Soil. — An abundance of fibrous loam of a character which suits the particular crop to be grown, is a most valuable asset in the florists' business. Flower-production under glass is intensive agriculture, therefore, sufficient soil in which to grow crops may be transported with more or less ease. Nevertheless, if an abundance of soil of a physical and chemical character which exactly suits a particular species of plant be easily available, the cost of transportation and preparation will be considerably lessened and the plants grown more economically. There are few broad margins of profit in flower-production. Products are quickly perishable, competition is keen and prices variable, so that forethought in regard to economy in installing and maintaining a range will be of immense value in increasing the finances after the houses are established. The owners of one of the largest rose-growing firms in the East studied soil characters of different locations for several years before deciding on a site for their range. They analyzed many soils until at last they found their

ideal. A member of the firm announced that a location had been found and remarked that they had a gold mine in the soil. Their subsequent success is proving the correctness of the statement.

While other florists' crops are perhaps less particular than the rose in regard to soil characters, nevertheless all species require soil of medium texture which is fairly retentive of moisture, yet one which is porous enough to allow any excess of water to percolate through it easily.

As a rule, plants under glass grow best if the soil contains a mixture of medium sand, silt and clay. The proportions of these vary with different crops, and the plant-requirements in this respect are more definitely discussed in those chapters which deal particularly with cultural directions for these crops. Several florists' crops, for example, carnations and violets, are grown part of the year out-of-doors, so it is important that the soil in the field be of a character suited for their culture. The character of the subsoil on these areas is likewise of special importance, for upon this depends in a large measure the effectiveness of drainage which is so important for a healthy development of these crops.

32. Drainage. — If soil where greenhouses are to be built has naturally an open subsoil, and if it be so located that natural drainage takes place, conditions are more ideal. However, this condition cannot always be found and if other important factors are present, and natural drainage is imperfect, artificial methods by tiling or open ditches may be resorted to effectively. After the drains are in place, the location for the houses should be graded sufficiently so that all surface water will be removed quickly. It is fundamentally important that there be most excellent drainage conditions both within and without

the houses — Large amounts of water must be used in plant culture and unless this percolates readily through the soil, stagnant conditions are brought about which are detrimental to plant growth and which cause disease. Outside surface drainage is important, for large quantities of water accumulate by reason of the large areas of glass roofs, and unless this water is disposed of, serious results to the foundations of the houses may follow. Money spent in providing adequate drainage is money well spent, but forethought in selecting the site makes it possible to eliminate much of this expense, and the later financial results will be better. It is especially important that all basement areas and boiler rooms be so drained that there is no standing water in them during any season of the year.

33. Slope of the land — As a rule, land which slopes gradually to the south and east is most ideal for light conditions. Although greenhouses are frequently built on quite steep slopes, a gradual slope is to be preferred because of increased ease in constructing and working the houses. Coal transportation, cartage and other work about the range are also done more easily. Greenhouses most generally extend from east to west, for reasons mentioned in the chapter on greenhouse construction, consequently it may be necessary to grade somewhat before houses are built, if the slope to the east is very pronounced.

34. Amount of land available. — In locating a new range one should always provide plenty of room for expansion. One rarely foresees future developments of the business. Many ranges have grown far beyond the expectations of their builders, and a number of prominent growers now regret that they have no more land available on which to build additional houses. A division of the

range into different sections increases considerably the cost of running. It is better to be perfectly sure that as more land is needed, it may be obtained at a reasonable figure.

An important factor which is often overlooked in establishing a range is the location of the houses on the given area. Many times the first houses are so placed that they interfere seriously with the location of later houses. Frequently, valuable land cannot be utilized to the best advantage because of this oversight.

While it is true that the greenhouse industry does not require such large areas of land as are demanded for other horticultural pursuits, still enough land, aside from that covered by glass, should be available so that a quantity of fresh, fibrous loam for composting may be obtained each year. If it is necessary to purchase soil for composting, the cost is considerable. Should the supply of sod-soil be insufficient so that virgin sod is not obtainable each year, the soil may be plowed, fertilized and crops planted for a year or two, when it may again be seeded. If one or two crops of grain or leguminous cover-crops be plowed under, the fibrous soil-contents will be improved.

35. Sale value or rental value of land. — It is rarely advisable to build greenhouses on rented land unless a long-period lease may be obtained. Greenhouses are not easily moved, and when taken down and rebuilt, loss by breakage of glass is considerable no matter how carefully the work is done. When urban prices of land prevail and when taxation is high, it is usually best to locate outside city limits. Often increasing land values and the consequent taxes in rapidly growing cities make profitable plant culture in an established range almost impossible. In such a case, property should be bought well outside city limits, and the business gradually moved

there, with the expectation that in due time the city property may be disposed of at a figure which will warrant a sacrifice in removing the range.

36. The farm as a location. — Large flower-producers are now getting into the country, where farm values are low. There is an increasing belief that the flower-producer should be a "flower-farmer," and since manures and fertilizers are becoming more expensive and more difficult to obtain, it is the duty of the flower-grower to make these manures on the farm by means of the dairy herd. Many large rose-producers have found it impossible to buy enough cow manure for their crops and have therefore established a large dairy herd in connection with the greenhouses. As one rose-grower expresses it: "The manure made by the cows during the night goes to feed the rose plants the next morning." These plants take such manurial elements as they need, and the remainder is left in the soil. When the blooming season is over and the benches are to be re-filled with fresh soil, the old soil is taken to the grass-lands and spread as a top-dressing. Thus the fertility of the farm-land is maintained and excellent crops of grass are produced for the dairy herd.

Automobiles are fast supplanting horses for city trucking and transportation, consequently city stable manure, which is such an important factor in plant culture in suburban sections, is becoming more difficult to obtain.

As has been said, such a farm range should be located on a railroad which has several through express trains daily to some large business center so that the products may reach markets quickly. If it be within easy shipping distance to several large cities, so much the better. For example, to locate in a country section midway between Boston and New York, with other intermediate smaller

markets available, and on a line of direct transportation, would be more advantageous than to locate in the immediate vicinity of either large city. Wholesale markets are ready to take the produce and to dispose of it at reasonable rates, and there are also co-operative flower markets in some large cities where salesmen may be engaged to sell the products. There seems to be, therefore, no good reason why the range may not be located at a considerable distance from the city.

37. Distance from railroad. — It is highly desirable that greenhouses be near a railway station. This is not alone to facilitate shipment of products, but to lessen the cost of coal transportation as well. Trucking is expensive, especially if it is necessary to haul the coal long distances over poor roads. It is a good plan to have a spur track to the boiler house. The business methods of the railroad in question should be considered, for on some lines trains are always behind schedule time and transportation is delayed. Promptness in delivery is a very important factor in flower-production, especially during rush seasons, which are usually holiday seasons when passenger traffic is heavy.

38. Water supply. — Every greenhouse should have an abundant supply of water under sufficient pressure so that plants in several parts of the range may be syringed at the same time. In sections not supplied by city water, the question of the best method of obtaining water should be carefully studied. For small ranges, windmills are quite satisfactory, provided there is a storage tank of sufficient capacity to furnish a constant water supply. This is without doubt the cheapest method, but for a range of any considerable size it is out of the question; for to get sufficient pressure for syringing, the tank must

be elevated considerably, and when a large tank is required, this is impracticable. The uncertainty of action of a windmill also makes it objectionable.

Where steam is used for heating, a small steam pump may be bought for a comparatively low figure. This will pump water from any well and gives excellent satisfaction. In large ranges where a manure tank is used, the same pump may serve to force both clear water and manure water over the range. Such a pump of sufficient capacity for 100,000 square feet of glass may be bought for less than \$400.

A gasoline engine and pump would be somewhat cheaper, and when hot-water is used for heating this would be required. Such an equipment can be used with a steel expansion tank as an air chamber, so that the water can be pumped directly into the pipe system at a pressure of twenty-five, thirty or forty pounds to the square inch. This should give sufficient pressure for syringing any species of plants.

The character of the water supply is of considerable importance. That which comes from a city supply drawn from an open reservoir is usually excellent. If it is pumped from a near-by pond or river, it is usually highly satisfactory. When taken from driven wells, the water is often very cold and often lacks chemical constituents which are beneficial as plant food.

39. Atmospheric circulation. — In the earlier days of flower-growing, it was thought advisable to build green-houses in valleys or where they were protected by wind-breaks. It was also thought desirable to excavate and sink them well into the ground so that the interior heat might be conserved. These ideas have been largely abandoned by prominent flower-producers of the present

day, and houses are located on quite exposed areas, provided that other important factors warrant the selection of such a site. Good air drainage about the houses purifies the atmosphere and renders plants less susceptible to disease. If there be a grove of evergreen trees a little distance from the range on the north or northwest, the driving force of the wind is lessened and its suction force over the ridge of the houses is reduced, and there is less breakage of glass.

40. Climatic conditions. — One factor which is frequently overlooked in deciding on a location is the fact that in certain localities there are a large number of cloudy or "gray" days. The flower-grower watches the sunshine closely, for he realizes the benefit which comes to his pocket-book through an abundance of bright, clear days, especially in midwinter. In many sections, frequent fogs are prevalent, especially during the morning when light factors are important. In certain sections of the United States, it is impossible to grow American Beauty roses satisfactorily because of an abundance of cloudy weather. Growth is not satisfactory, and the rich coloring of blooms is defective. In other sections, where the atmosphere is "rare" and clear, they develop to perfection. Thus this branch of the industry has become localized.

Low outside temperatures are not the all-important factors in flower-growing under glass. By sufficient piping and careful regulation, cut-flowers may be grown just as satisfactorily in Canada and northern United States, and without a greatly increased coal consumption, as they can farther south. The period when high temperatures must be maintained may be somewhat longer and the cost of production therefore somewhat increased. However, in the larger ranges, especially where roses are

grown, fires are run almost constantly even during the warm nights in summer. This drives out an excess of moisture which would otherwise accumulate on the foliage and induce disease, especially mildew.

41. Labor supply. — As the number of men employed under glass is not large, the question of labor is not so important as in vegetable-growing and other branches of horticultural activities. Nevertheless, a large flower-producing industry requires a considerable number of laborers, and conditions should be such that they can be readily secured and retained. As a rule, laborers do not like to travel long distances for employment, therefore living conditions in the immediate vicinity should be such that men may be easily kept. A grower should aim to make his help contented with their living conditions, for this goes a long way in solving labor problems. A man's value should increase each year as he becomes better acquainted with the work and the owner's methods.

42. Character of the community. — The character of the community is a factor which is of great importance in the location of any industry. As a rule, rural sections are safe places in which to live, and especially good for children. The educational advantages, however, should not be overlooked. Good public schools should be easily available, and churches should be within easy reach, also enough social interests to make life enjoyable. Automobiles and telephones have made it possible to live longer distances from social centers and yet keep closely in touch with these interests. A flower-grower should not be so closely wrapped up in his personal interests that he neglects his duties to his church and town. He should take an active interest in everything which pertains to the welfare of both.

CHAPTER IV

GLASS STRUCTURES AND THEIR ARRANGEMENT

EARLY American greenhouses were deficient in ideal light conditions. They were built principally of wood, and many windows or glass shutters were inserted for light. Previous to 1850 these glass areas were portable, being similar to sash-houses of to-day, except that the roofs were largely of wood. Present-day greenhouses contain a maximum amount of glass and a minimum amount of wood. An effort is made to increase the light efficiency in every possible way, therefore it is necessary to eliminate, by construction and arrangement of houses, every shade-producing factor.

IMPROVEMENTS IN CONSTRUCTION METHODS

About 1855, Frederick A. Lord, founder of the present firm of Lord & Burnham, erected in Buffalo, New York, what is said to be the first permanent glass-roofed house. This construction met with favor with the few men of that period interested in flower-growing, and several houses similar to Mr. Lord's were soon built. This was a beginning, but the houses of that period were very crude and primitive. The frame-work was of large dimensions, the glass small in size, heavy and thick. Interior light conditions were correspondingly poor. Still they were a vast im-

provement over sash houses, and from the crude greenhouse of that period the present-day modern house has been evolved.

This evolution has been gradual, and inasmuch as students of light factors have learned much during the last decade, the present-day house represents a high degree of light efficiency. Gradually, the heavy, wooden frame has been replaced by lighter wooden material, and this, in turn, has given way to steel frames. Wood is not an ideal material for greenhouse construction. It decays too rapidly under the conditions which prevail in these houses. Decay in wood tissue is caused largely by wood-destroying fungi which develop rapidly under warm, moist conditions such as are found in greenhouses. It has never been possible, however, to eliminate wood entirely from the superstructure, because metal responds so quickly to the action of heat and cold that the unequal expansion and contraction breaks the glass. Consequently, wood is still used as a medium on which to place the glass. A study of the relative strength of different species of wood has made possible, however, the manufacture of wooden sash-bars of much smaller dimensions. Improved methods of manufacture of American glass have improved the quality greatly, and have made possible the use of larger sizes, so that interior light efficiency has been greatly increased. Foundations of wood have been replaced by those of concrete, and this has been an important step in increasing the durability of houses. Foundations are especially important in greenhouses, for as soon as they weaken, the superstructure quickly gives way. Wooden interior supports have given place to those of iron pipes, thereby eliminating much shade and increasing to a considerable degree, the strength of the supports.

SIZE AS A FACTOR IN CONSTRUCTION

Early American houses were low at the ridge, narrow and short. It was considered impracticable to heat large areas under glass, and it was also considered essential that plants be near the glass. Gradually these ideas have given way to a preference for the wide, long house which is high at the ridge (Fig. 5). The reasons for this change of opinion are:

43. Comparative cost of construction. — It has been proved that it costs less to build one large house than it does to cover an equal ground area with several small houses. There is less cutting of pipe in erecting the framework, sash-bars may be more quickly laid and glass more cheaply put in place.

44. Economy in heating. — It was the early opinion of growers that large houses could not be economically heated, but it has been demonstrated that there are fewer changes of air during a given period in the large house than in the small one. The heating pipes are farther from the plants, therefore there is less intense heat directly about them, and the heat is modified to meet better the requirements of plant growth. When the volume of air is once heated in large houses, a sudden drop of temperature in the pipes does not affect the heated air as rapidly as it would in the smaller house.

45. Economy in labor. — Plants in one large house can be cared for with less labor than when they are in several small houses.

46. Improved light and atmospheric conditions. — Perhaps, however, the greatest advantage of the large house lies in improved atmospheric conditions. Plants are farther from the ventilators and are therefore not subjected

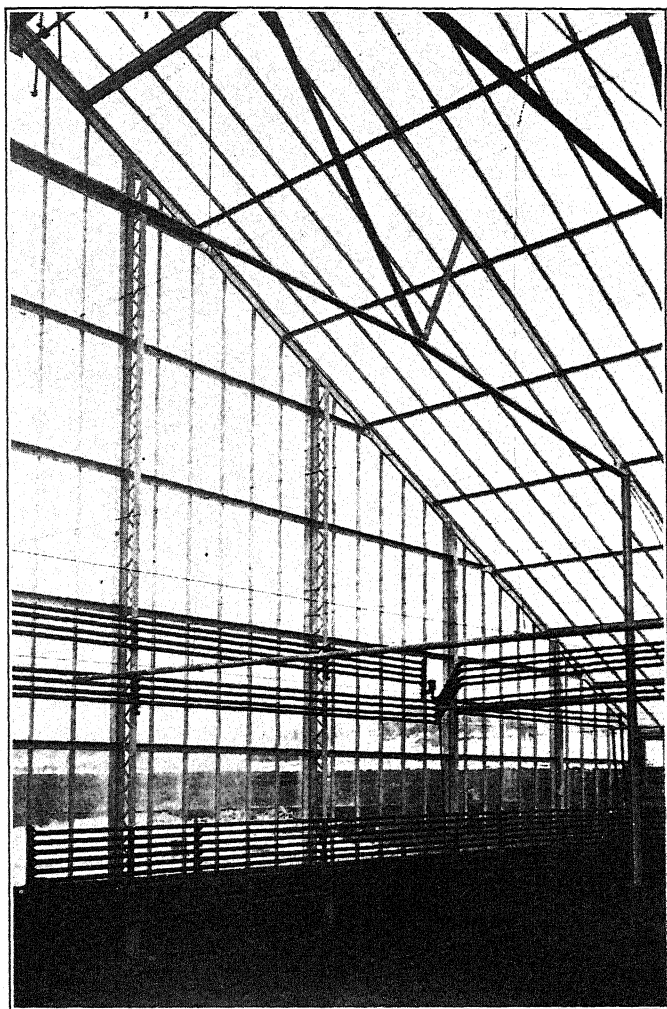


FIG. 5.— A modern greenhouse of large dimensions; note the arrangement of heating pipes and the reinforced end posts.

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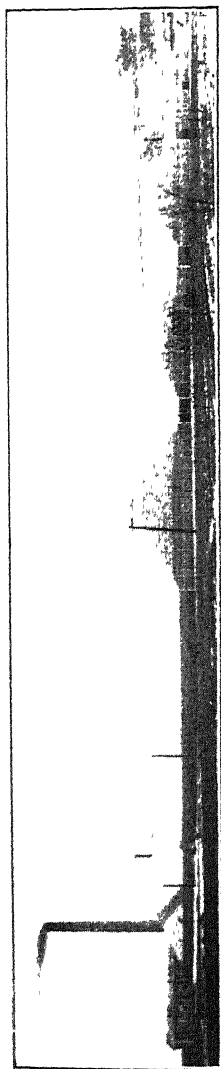


FIG 6 -- A modern, well-arranged greenhouse establishment

to drafts and consequent chilling. Ventilation is therefore more ideal, and plant growth is much more healthful. This is particularly true in rose houses, where a sudden change of temperature about the plants will cause an abundance of mildew to appear quickly. In larger houses, plants have conditions more nearly like those outside. Plants have grown equally well a considerable distance from the glass, as when close to it, and in the house of greater elevation there is plenty of head room for development of blooms. This is particularly true in some modern sweet pea houses, where the side walls are eight feet high.

There are some conservative growers who still believe that the tendency towards large houses has been overdone. The writer believes, however, from his observation and experience, that the moderately large house is the most satisfactory from a commercial view-point. Extremely large houses may come into permanent favor at a later date, but their value has not as yet been fully demonstrated.

ARRANGEMENT OF HOUSES FOR CONVENIENCE AND FOR
LIGHT

In buying an established range, one must take houses as they are found. In the larger number of cases, ranges have been established some time, and the houses exhibit a peculiar arrangement. As additional room has been needed, a house has been "tucked on" wherever it has been found possible to place it. It puzzles a visitor to find his way about such a range. In the care and upkeep of such houses, many unnecessary steps are taken and much valuable time is wasted.

47. Arrangement for convenience. (Fig. 6.) — Extremely long houses often make it necessary to travel long distances, and their management is not always economical. In modern ranges there is usually some sort of a connecting house, and growing houses lead from this. The connecting house is narrow and serves as a thoroughfare for workmen. Heating mains usually extend through these houses. They are quite frequently used for propagation. The connecting houses are variously placed. Sometimes they run through the center of the range, and again they may be at either end, as best suits the convenience of the location. The connecting houses should be low enough so that light is not shut off from growing houses. Usually the alley-houses simply serve as a connecting passage between the larger houses, but in case they are placed in the center of the range and crops requiring different temperatures are grown in the houses on either side, partitions frequently are run through these houses, thus making the alley-house continuous. Such partitions should be avoided wherever possible, for they are detrimental to the best light conditions.

A careful study of arrangement before a range is built will often eliminate much unnecessary labor. Houses in which potted-plants are to be grown should be near the potting and soil rooms. Propagating rooms should also be as near the potting room as possible.

48. Arrangement for maximum light effects — That a greenhouse has the maximum light efficiency is of great economic importance, especially where flowering crops are grown which require abundant light for production of blooms. During late spring, summer and early fall, this is of less importance than during the winter months. Then cloudy weather may prevail, and even at best the sun at meridian is low towards the southern horizon, and it is of the utmost importance that every ray of light possible penetrate to the food-preparing parts of the plant. Roses especially require an abundance of light, and to produce first grade carnations, winter light conditions should be ideal. For greatest light efficiency, it is considered preferable by eastern growers to have separate houses of uneven-span type, and to place them so they will extend from east to west. They should be far enough apart so that when the sun is low in December and January, shade from the ridge of the south house will not fall above the foundation line of the house just north.

Preference for uneven-span houses lies in the fact that in them a larger area of glass is brought more nearly at right angles to the sun's rays and the light efficiency is thus increased. Carrying the ridge farther to the north also eliminates the possibility that shade from this will be cast on the north bench, as the sun becomes higher during spring months. It is essential that uneven-span houses run east and west. If a given location demands that

houses run north and south, they should be even-span or of the ridge-and-furrow types.

In locating houses which run east and west, it is considered preferable to place them a few degrees south of west. In this way, the maximum number of sun's rays are caught during the morning when most intense light conditions are needed. Every possible means should be taken to eliminate factors which may cause a loss of light during the morning or the late afternoon hours. For this reason, it is important that partitions be eliminated as far as possible, for they diminish the intensity of light conditions on either side of them during the morning and afternoon.

ACCESSORY BUILDINGS

In connection with greenhouses, there are boiler rooms, storage houses, potting and soil rooms, shipping rooms with cold storage sections adjoining, and rooms for bulb storage. If the range be a large one, there is usually a carpenter's shop and an iron-working shop. Large growers manufacture their boxes for shipping, their flats and other smaller wooden materials used about the range, and they also do their own construction work. Wagons and many implements and tools used about the range are home-made. This necessitates a staff of carpenters and painters. Large ranges also have iron-working rooms with forges and other equipment, where boiler repairs are made, and where heating pipes, pipe supports for interior construction and other iron work in connection with the building and general up-keep of the range, is done. In large rose ranges, the manure tank, which is usually separated somewhat from other rooms, is an important factor in equipment.

All of these buildings and rooms should be arranged so

that they can be maintained with a minimum amount of labor. They should also be located so they will not detract from the efficiency of growing houses because of their shade. If they can be placed on the north side of the range, this is not so likely to occur. When flower crops are grown, it is especially important that the boiler room be far enough away, or so placed that shade from the chimney does not fall on the greenhouse.

TYPES OF HOUSES

For commercial purposes there are practically but three types of houses used; namely even-span, uneven-span, and ridge-and-furrow. Occasionally lean-to houses become important factors in ranges because they economize space.

49. Even-span houses. — Even-span houses have the advantage of adaptation to almost any location. They are the general utility houses adapted for almost all purposes. Light conditions, however, are not so intense as in uneven-span houses, therefore they are better suited for those crops which do not require maximum light conditions. They are for the most part satisfactory for carnations, violets, sweet peas and bedding plants. They may be built any length, and the width may vary from nine to sixty feet, or even wider, according to the requirements of the grower. In deciding on the width, the number and width of the walks and of the benches which the house is to contain must first be determined so there may be economy in interior arrangement.

50. Uneven-span houses — The uneven-span house is more distinctly a forcing house. As will be noticed in the next chapter under the consideration of the construc-

tion of the roof, the more nearly glass is brought at right angles to the sun's rays, the greater light efficiency it has. In so-called two-thirds and three-fourths span-houses, more glass is so placed. In uneven-span houses, therefore, there is less reflected light than in even-span. Rose-growers in the East prefer this type of house. Comparative widths of the south span and the north span vary with different builders, but the preference is to place the ridge far enough to the north so that it casts no shade on the north bench at any time of the year.

In older houses it was customary to elevate the north bench considerably to bring plants nearer the glass and to give them better light conditions. It is now considered better to raise each bench and to grade the soil in the houses before the benches or beds are installed, so that, while all benches are of the same height, each bench towards the north is elevated about six inches above the one on the south. This facilitates ease in working among plants and eliminates unhealthful atmospheric conditions which prevailed under high walks and benches in older houses.

51. Ridge-and-furrow houses. — Ridge-and-furrow houses are much in favor in the Central States. These houses are modifications of even-span houses. They are so built that extensive areas are practically under one roof.

This system permits of a lessening of the cost of construction, for there are fewer outside walls to build. As they cover the entire area of land there is no unoccupied land between them, and where land values are high, this is quite an important factor. It is possible to heat these houses economically because there is less exposed wall area than in separated houses. They may also be worked easily,

for practically the same conditions regarding maintenance and up-keep prevail as in large, separated houses.

Several disadvantages of this type of construction might be mentioned. In sections where snow-falls are heavy, there is often an accumulation of snow in the furrows which causes a serious strain on the roof. To overcome this, metal gutters are now most frequently used, for they are rapid conductors of heat. Heating pipes are placed beneath the gutters, and this serves to melt the snow as it falls. Occasionally steam pipes are placed on the outside of gutters, and they are so valved that when a heavy fall of snow is in progress, live steam may be turned into them, thus melting the snow rapidly.

It is quite essential that the roofs, and especially the gutters, be strongly supported. Gutters should be large enough to dispose of a large volume of water rapidly, for after a heavy downpour, sufficient water should not accumulate in the gutters to cause them to overflow and produce drip in the houses.

Another serious objection to ridge-and-furrow houses is the loss of light which results in the center house from the shade of those on either side. This is especially objectionable during the morning and late afternoon. There is also considerable shade cast by the gutters at all hours of the day. In ranges in which there is a large output, shade cast by gutters is not considered objectionable. It is claimed that while those benches just below the gutters may not produce as many blooms during certain months, they will bloom more freely and with better perfection after those plants which have received full sunlight have become diminished in productiveness. Therefore, the yearly average is as great on the shaded benches as it is on the unshaded. The prices received

for the late blooms will not be as high, however, for they are produced at a season of the year when the market supply is abundant and when there is less demand for products. Side ventilation in ridge-and-furrow houses is out of the question, and there is considerable breakage of glass near the gutter of the adjoining house, from snow and ice which slide from the roof.

52. Curvilinear houses. — Houses with curvilinear roofs were at one time much in demand, especially on private estates and in city parks, where houses built along especially artistic lines were desired. It was also thought that curved glass was especially effective, for more glass area was brought directly at right angles to the sun's rays than in straight-roofed houses. These never proved efficient houses, however, in which to grow plants, and they were more especially used for conservatories. The curved members of construction and curved glass were expensive, and this type of house is less frequently built at the present time than formerly. Houses with straight roofs, but with curved glass at the eaves, are now considered preferable to houses with curvilinear roofs. These are attractive to the eye and also are excellent houses in which to grow plants.

SIMPLE GLASS STRUCTURES, THEIR CONSTRUCTION AND EQUIPMENT

It is possible to construct greenhouses less pretentious than those already described. Many simple structures for housing plants over winter are efficient and desirable. They may be attached to the dwelling house, the stable, the garage, or they may be separate buildings. If attached to a dwelling house, the boiler which heats the

dwelling may be utilized to heat the greenhouse. Simple "lean-to" houses are generally heated in this manner. If the wall of the dwelling be of cement or brick, the problem of attaching the greenhouse is a simple one. If it be of wood, care should be taken that the greenhouse, with its warm, moist atmosphere, does not cause the foundations of the structure to decay.

53. "Lean-to" houses. — A "lean-to" house is inexpensive and easily heated, but as a rule the plants grown in it do not receive maximum sunlight. Such houses frequently are of value to a commercial range, for they can be placed against a boiler house or other building, where land can be utilized in no other way. They should have a southern exposure and precautions should be taken to prevent snow from sliding from the roof on to the glass. "Lean-to" houses are excellent for those cool crops which do not require maximum light conditions, but as the plants get light from but one direction, they have a tendency to be unsymmetrical. "Lean-to" houses are often used commercially for violets or pansies, and may be utilized for growing many plants of interest to the amateur flower-grower. Simple, inexpensive, even-span houses may also be attached to home buildings and heated in connection with them.

54. Hotbeds. — Sometimes simple hotheds are very satisfactory places in which to grow flowering plants. They should be located in a protected spot. If they are south of an evergreen windbreak, the location is more ideal (Fig. 8, lower). They may be built along the south side of a dwelling house and heated by one or two pipes from the house boiler. Often enough heat may be obtained from windows that open into the cellar or into the greenhouse (Fig. 7).

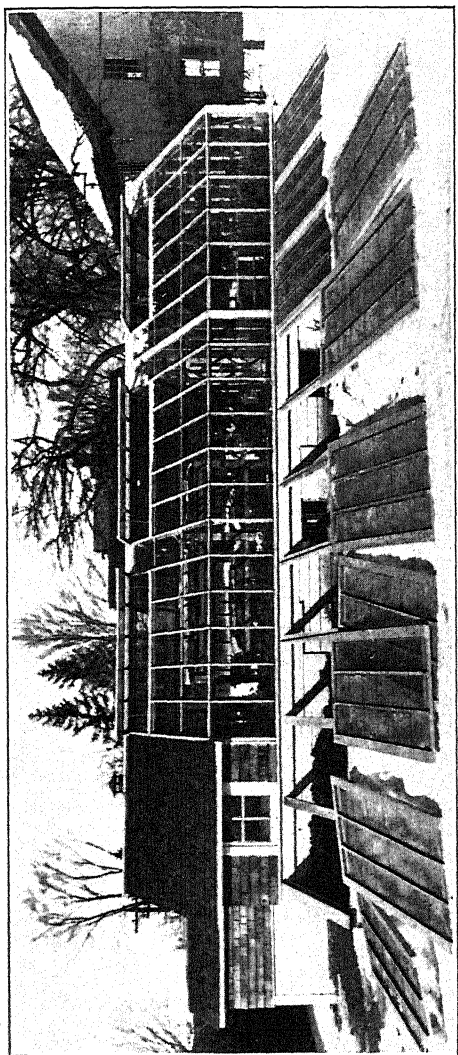


FIG. 7. — A hotbed built on the south side of the greenhouse where the temperature is governed by panel ventilators in the side walls of the house.

In constructing a bed to be heated from the greenhouse or house cellar, a sub-frame is first built. This is about four inches thick, two to three feet in depth, and is made of wood, brick, concrete or other material. An extension of this frame is built above ground, and on it the sash rests. To give plenty of head room for the plants, the frame is built about six inches above ground on the south side and about twelve inches on the north side. The sub-frame is filled to within about one foot of the top with porous soil which insures perfect drainage. Six inches of well-enriched loam is then placed over the subsoil. This brings the soil twelve inches from the frame on the south side and eighteen inches on the north side. Plants are set directly in this surface loam. The heating pipes may be run along the foundations of the house. The frames should be protected with mats and shutters on cold nights. These should be removed every bright day, and especial attention given to ventilation, or the plants will smother. The frame should be kept free from snow.

The term hotbed generally means a frame constructed as the one just described, but one warmed artificially by means of heat generated from fermenting stable manure. The manure acts only as a heating agent, not as a fertilizer. In selecting material for constructing the frame, it is well to decide on the most durable material even if the first cost is somewhat greater.

For permanent frames, concrete is the most durable. The sub-frame is eight inches thick and is made three feet below grade. Above grade, the ends of the frame are five inches thick and the sides four inches. The forms are first placed, and into these forms is poured the concrete. Hemlock boards, one by twelve inches, are used for the forms, with two by four inch studding for the

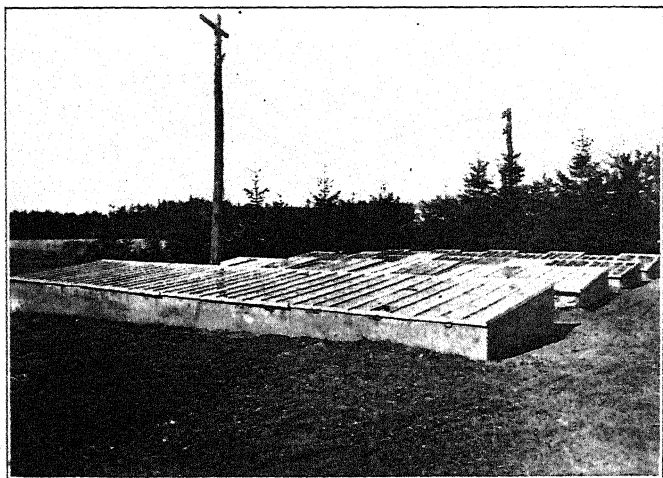
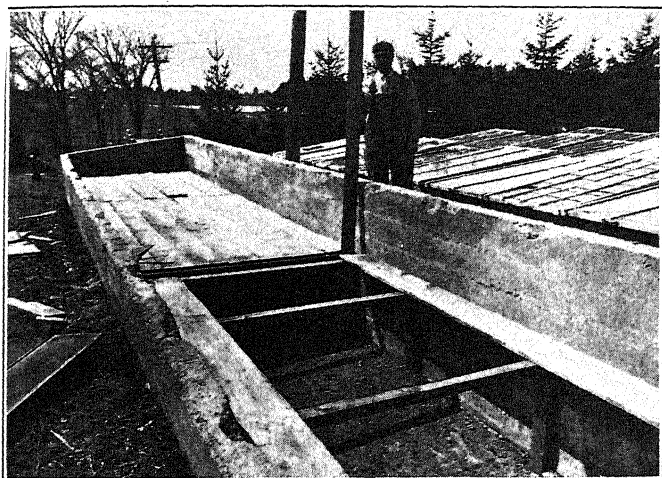


FIG. 8.— Upper. Concrete hotbed. Note the false bottom which may be used if decomposing manure is not needed for heating. This makes a convenient place for storing bulbs. Lower. Well-arranged hotbeds on the south of an evergreen windbreak.

battens and braces. The form is only temporary, being removed as soon as the concrete sets. Sometimes it is not necessary to place a form on the outside face of the sub-frame. The soil at the back is cut down, making a straight, even surface. This holds the concrete in place until it sets.

The standard mixture for concrete is one part cement, two parts clean, sharp sand and five parts broken stones, cinders or some similar material. This concrete is poured into the frame and tamped securely in place, care being taken that the finer mixture is against the outside of the form, thus making a smooth surface. Cross strips of two-by-three inch material are embedded in the top of the frame, before the concrete hardens. They are spaced every three feet and serve to support the sashes after they are placed. In making the concrete hotbed, it is necessary to board both sides of the form above the grade. The height of the frame above ground is usually the same as that described for the steam-heated frame. When once in place, the concrete hotbed is practically indestructible, provided it is well made. A concrete hotbed such as the one described, twenty-five feet long by six feet wide, should be built for approximately \$13.50; this would require eight sashes. The cost of the foundations and frame above ground for each sash would therefore be about \$1.62.

The next best material, from the standard of durability, is probably bricks, but while very satisfactory, brick frames are not so easily made as the concrete frames. Chestnut and cypress are the two most lasting woods. Two-inch plank is used for the sides of the frames, and two-by-four inch material for the battens and braces. Hotbeds may be used as coldframes if decomposing manure is not needed for heating the soil. Deep frames of this sort

are excellent places in which to store hardy shrubs before they are forced. A false bottom may be used and the frame is then convenient for storing bulbs in the fall (Fig. 8, upper).

55. Coldframes — Coldframes may be made with a sub-frame, the same as that described for the hotbed, or they may be made with simply the frame above ground. Frames above ground are usually portable, and may be knocked down easily and the location changed. The only difference between a coldframe and a hotbed is that there is an under layer of fermenting manure in the hotbed, while frames have no artificial heat. Frames are used more particularly for storing hardy species and bulbs; also for giving some protection to plants before they can be planted safely in the open ground. Plants grown in greenhouses may be "hardened off" in coldframes. Hotbeds are started earlier than are coldframes.

56. Equipment for hotbeds and frames. — The material for equipping both frames and hotbeds consists of sashes, mats, board shutters and, in some cases, lath or canvas screens.

It is usually best to buy the sash. The standard size is three by six feet, and the price varies from \$2.75 to \$3.50 each, according to the durability of the sash and the care with which it is constructed. They should be kept in good repair and painted every year so that the putty will not crack, thus loosening the glass.

Mats for hotbeds and coldframes may be made of strong burlap lined with waste wool or cotton, and quilted. Mats may also be made of straw or similar material, depending upon the locality. If in the vicinity of hat factories, the matting in which the straw is shipped from foreign countries may be utilized for mats. They

should be made somewhat larger than the frame, to cover the side and the end. They are usually four and one-half by seven feet. Mats may be purchased from dealers and vary in price from \$1 to \$1.50.

During the winter, it is necessary to cover the mats with board shutters. They are made of five-eighths inch narrow ceiling boards, grooved and tongued, forming tight joints. They are held together by cross binders or cleats. The mats fit snugly on the frames, keeping out the cold; while the shutters hold the mats in place and protect them from rain or snow. The cost of shutters is approximately \$1.75 each.

In transplanting plants, it is often necessary to shade them from the direct rays of the sun. Some seedlings germinate better in partial shade, and it is advisable to have a few slat shutters for placing over the seeds and seedlings after they are sown or transplanted in the frames. Slat shutters are made of evenly spaced cypress pieces about three-fourths of an inch wide and one-fourth of an inch thick, and of the same size as the sash. They are held in place and braced by cross binders, then securely fastened with wire nails. Slats made in this way are light and strong. The cost is approximately \$1.25. A cheaper screen is made of a light frame of one-inch material with two cross braces, and covered with canvas.

CHAPTER V

BUILDING THE RANGE

ONLY the most important principles of greenhouse construction will here be considered, as it is impossible to condense in a limited space a detailed discussion of so broad a subject.

Commercial ranges are considerably different from those constructed for private or park conservatories. In the former, economy and durability are two very important factors. The ornamental character of the structure is of less importance.

TYPES OF CONSTRUCTION

Methods of building vary with almost every construction firm and with the ideas of individual growers. There are, however, a few general principles which are quite definite and distinct. The grower should decide which method will best suit his conditions, considering of course durability and comparative cost. The two methods of construction are all-wood houses and semi-iron houses. The latter may be subdivided into the flat-rafter type, pipe-frame type and the U-bar type.

57. All-wood houses. — The first type, the all-wood house, continues to be used to a considerable extent by commercial growers. With durable material for foundations and careful attention to construction, avoiding

the possibility of moisture-collecting joints, and with frequent and careful applications of paint, all-wood houses will last a considerable period. The framework must, of necessity, be of larger dimensions than when iron is used, therefore light conditions are not the best.

In selecting material for construction, a light, strong, straight-grained, durable wood allowing of small dimensions should be used for the superstructure. Wood with the grain running diagonally is much weaker than wood with a straight grain. White and yellow pine are frequently used, but they are not equal in value to cypress or redwood. Fortunately the supply of these is sufficient to meet the demand at the present time, but with a diminished output and more and larger greenhouses constructed each year, there will eventually be a scarcity of cypress and a demand will come for other durable woods.

58. Semi-iron houses.—The methods of combining iron and wood for construction purposes are many and varied. Each firm of greenhouse builders has its own particular method which, in its opinion, is far superior to any other.

Flat-rafter sectional houses (Fig. 9).—In flat-rafter sectional houses, a combined steel side-post and roof-rafter, three inches wide by one-fourth inch thick, extends from a foot-piece which is firmly embedded in concrete, or from an iron sill which is laid on a concrete wall, to the eaves and ridge of the houses. These posts and rafters are placed eight feet four inches apart, and these sections may be extended indefinitely by removing the end partitions in the houses. Purlins of angle-iron extend from rafter to rafter and are held in place by iron lugs. Each rafter is capped with a narrow, wooden sash-bar, and because of the strength of rafters and purlins, all sash-bars

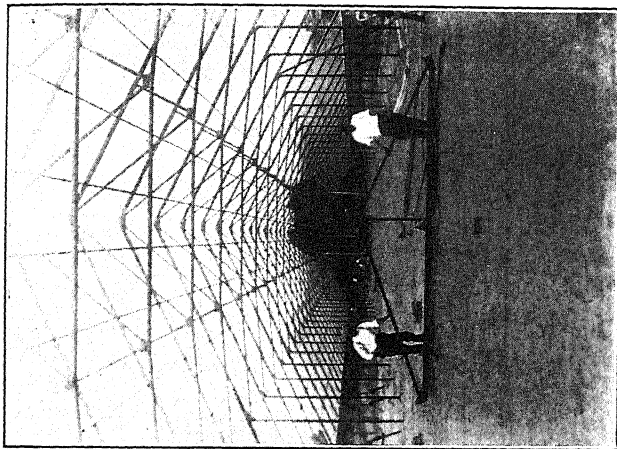
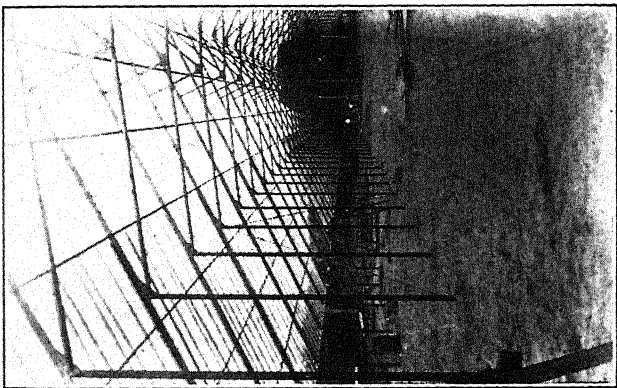
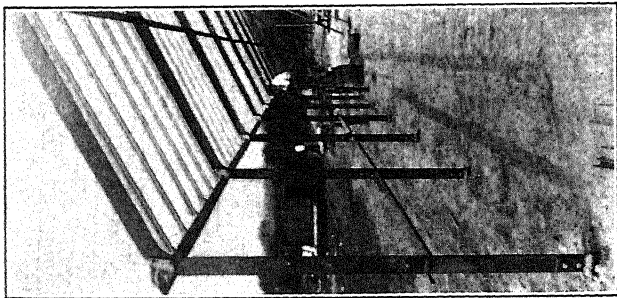


FIG. 9. — A flat-rafter sectional house with "giant" truss. Left, Flat-iron side-post and rafter bolted to foot-pieces which are embedded in cement. The side-sill and angle-iron brace-plates are bolted to these. Center, Supporting angle-iron posts and purlins. Right, Half of the "giant" truss.

in this type of house may be narrower and thinner than in all-wood or pipe-frame houses. The sash-bars are usually one and one-half inches by seven-eighths of an inch.

Pipe-frame houses. — Typical pipe-frame houses have a framework made of from one to two-inch iron pipe, the size depending upon the position of the pipe and the size of the houses. Such frames are largely independent of the sash-bars and glass material, but the sash-bars are held firmly to the latter by means of various iron-clips, lugs and U-bolts. In semi-iron pipe-frame houses, iron pipes are used for side posts, they being firmly embedded in concrete and extending to the eaves. Interior pipe columns support purlins which are firmly attached to the sash-bars by metal clips.

U-bar houses. — The U-bar method of construction is little used as yet in commercial greenhouse construction, its expense making it impracticable. This method is often used in building private conservatories and in public parks. In these houses an iron sill is attached to the foundations and to these, at definite intervals, iron sash-bars are firmly bolted. These sash-bars are made in the form of a U and have a wooden strip inserted in this metal so that the interior of the house, which is the most liable to decay because of warm, moist, atmospheric conditions, is practically all glass and iron, while the outside, which is the most susceptible to changes in temperature, is glass and wood. The U-bar houses have thus overcome much of the danger of breakage of glass due to unequal expansion and contraction of metal sash-bars. If the outside wood is kept well painted, decay rarely occurs, and if the interior is also frequently painted, rust will not corrode the sash-bars. The U-bars are usually galvanized to prevent rusting. Because of the

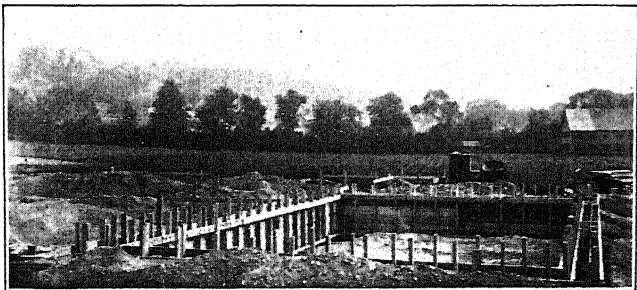
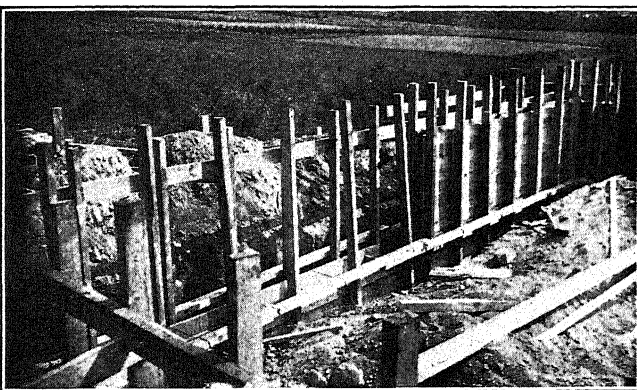
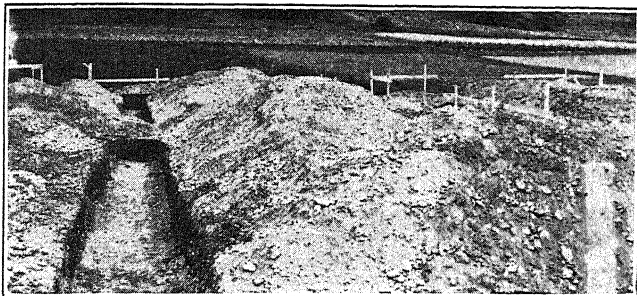


FIG. 10. — Building the foundations. Upper. Excavating for foundations. Middle. Placing the forms. Lower. The forms in place.

strength of the sash-bars, metal eave-plates are unnecessary, and curved glass is used at the eaves, thereby increasing the light efficiency.

METHODS OF BUILDING

59. Grading. — Having decided on the site and the type of house, the next thing to be done preparatory to building is to drain and grade the land. The surface soil should be plowed and all loam removed with horses and scrapers, for this loam makes valuable material for a compost heap and may be used later in interior beds. This can usually be accomplished more easily and cheaply before the foundations are laid, unless it is necessary to make a deep fill. Even then, if the interior of the houses require considerable filling in preparation for foundations for beds, this should certainly be done first.

If much filling is to be done in preparation for the beds and benches, as is often the case in uneven-span houses, this filling should be of a coarse, gravelly nature that drainage may be perfect. Often it is necessary to haul this material from some distance. After rough grading has been done, all top grading is left until the range is completed.

60. Foundations. — After grading so that the land is comparatively level but with sufficient slope so that all surface water will be carried away from the house, the next step is to excavate a trench for foundations. The width of this trench will vary with the size of the house and the width of the foundations required. As a rule, for large houses, the foundations are rarely less than eighteen inches thick. The trench, however, must be much wider to facilitate placing the forms in position. A width of at least three feet will be required (Fig. 10, upper). The

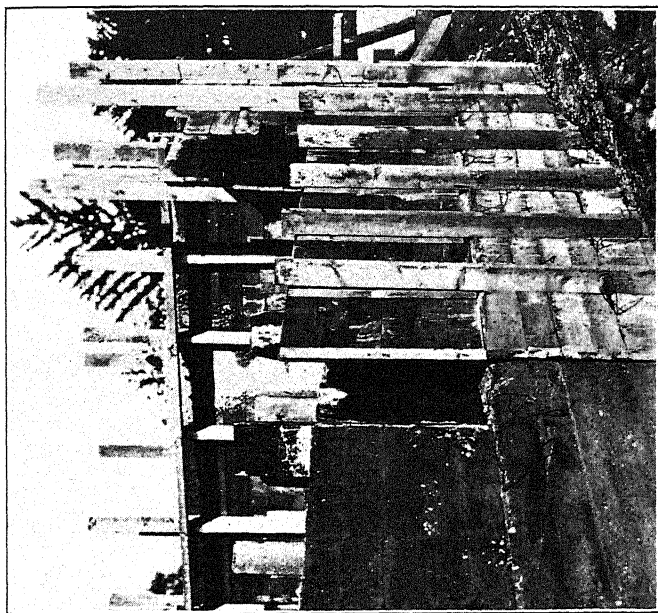


Fig. 11. — The mixing of cement ; and the removal of the forms from cement work.



A cement mixer in operation.



Mixing cement by hand.

depth of the trench will depend largely on the character of the soil. It is necessary in the northern states to go well below the frost line. This usually will be three feet. Where there has been considerable grading, it is always best to carry foundations to the original subsoil. Money spent in establishing firm foundations is money well invested, for on the foundations depend, to a large extent, the success or failure of the superstructure.

For foundations a "grout" made of one part cement, two parts sharp sand and five parts broken stone or "cobbles," is as inexpensive and satisfactory as any material. Forms of twelve-inch hemlock boards are first put in place and held firmly by two-by-four inch hemlock strips (Fig. 10, middle and lower). If the fill is a deep one, a row of wires, the size used in baling hay, is placed about every six feet, to prevent the cement from forcing apart the upright strips. When the forms are later removed, these wires are left in the cement but may be easily broken off. In preparing "grout," the cement, sand and cobbles are thoroughly mixed when dry, then sufficient water is added to form a mixture of a consistency to pour easily into the forms (Fig. 11, left). This should be thoroughly tamped into place and allowed to harden before the forms are removed. When the side-walls above grade are of concrete, smaller stones are used in the mixture and more care is taken in placing this in the forms. As the material is poured in, a long-handled shovel is used to draw the coarser stones into the center, and the finer mixture runs down against the forms. This prevents "voids," or unfilled places between stones, when the forms are removed (Fig 11, right). As wooden forms are expensive, it is possible to use the same boards several times in putting in the foundations. The boards

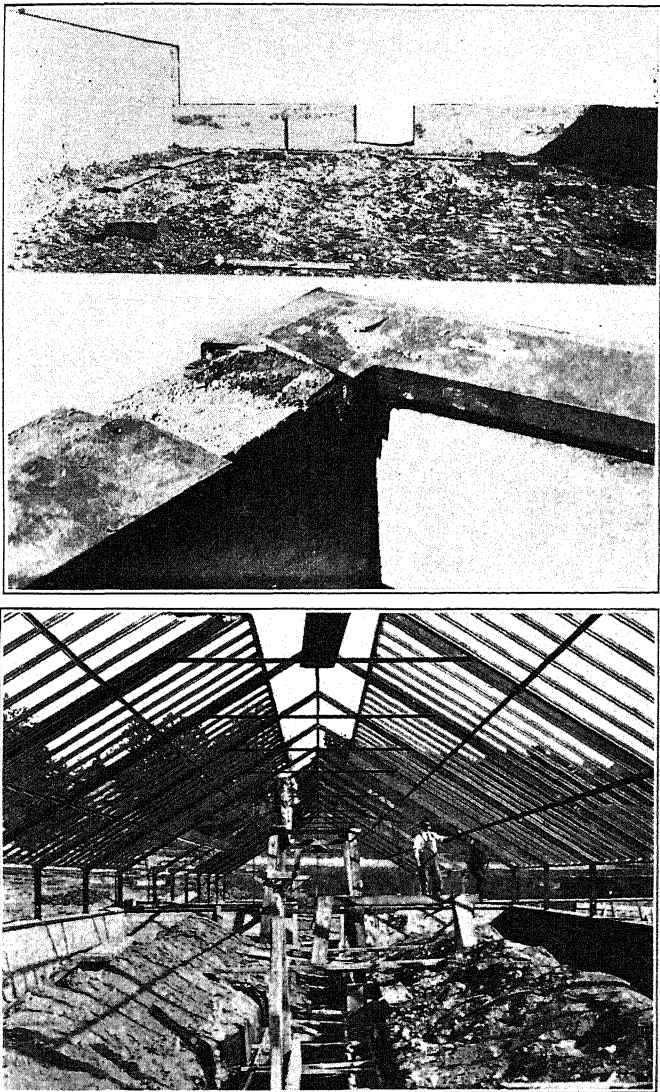


FIG. 12. — Upper. The finished foundations. Middle. Placing the sill. Lower. Erecting the superstructure.

used for forms may later be used for bottoms of wooden benches.

61. Side-wall construction. — The foundations usually come to the level of the interior grade of the house, and from here the side-walls begin. They may be of cement, wood, hollow-tile, concrete blocks, brick or stone. Preference is now given to cement because of its durability, and the expense is not much greater than for wood. In the end it is cheaper. There are various forms of side-walls, as follows:

Concrete capped with iron sill, to which flat rafters are attached. — In the first type of construction, the concrete side-walls extend from eighteen inches to three feet above the foundations, depending upon whether solid beds or raised benches are used in the interior (Fig. 12, upper). In large houses, the side-walls are usually ten inches thick. On these side-walls, nine-inch iron sills are held firmly in place by a fine mixture of one part cement to two parts sand (Fig. 12, middle). Flat-iron rafters are attached to this sill by iron lugs and bolts, and the upright sash-bars are held in place by the same means (Fig. 12, lower). No side-walls should ever be high enough to shade the first bench in the interior of the house.

Concrete capped with iron sill, with flat-iron posts extending to the eaves. — In the second type of side-wall, the construction is practically the same as in the first, the main difference being that a flat-iron post is used which goes only to the eaves, in place of the flat-rafter which extends to the ridge.

Wooden posts embedded in foundations, to which posts, wooden side-walls are attached. — In the third type of construction, wooden posts of six-by-six inch material and eight or nine feet in length are strongly embedded in the

concrete footings. If houses are to be uneven-span, posts for the north wall must be longer. They should be at least three feet in grout. Side-walls of large houses ought to be at least six feet above grade. The posts are placed about five feet apart and should be made of some durable material, such as cypress, cedar or chestnut. They are then sheathed on the outside with hemlock boards, planed on at least one side, and this planed side is placed on the interior of the house, for a smooth surface is less susceptible to decay. The outside of the boards is then covered with building paper and this in turn is covered as high as the glazing sill with matched boards or patent siding. The glazing sill is from eighteen inches to three feet high as in concrete side-walls. Above the glazing sill as far as the eaves, are upright sash-bars and glass, or ventilators for side ventilation, if such are used. Pipe posts may be used instead of wooden, and the wooden side-walls attached to them by means of U-bolts.

Pipe posts embedded in foundations, with curtain-wall of cement. — In the fourth type, two and one-half or three-inch iron pipe is used for the supporting posts. They are of the same length as the wooden posts just described, and are placed in the foundations in a similar way. A so-called "curtain-wall" of solid cement, and about four inches thick, is built above the foundations to the desired height, and is capped with a wooden glazing-sill (Fig. 13). Holes, of the same diameter as the pipe posts, are bored in the sills. The sills are slipped over the posts and are held in place by iron lugs which are fastened to the posts by means of a set-screw.

Pipe posts embedded in solid cement walls. — The fifth type of side-wall is similar to the fourth, but instead of the curtain-wall, a solid cement wall eight or ten inches

in thickness is used. This necessitates a heavier glazing sill, and in order to attach this firmly to the concrete, ten-inch bolts are embedded in the last layer of concrete in the side-wall, leaving enough length above the concrete to extend through the sill. The sills are then held firmly to the concrete side-walls by the nuts of the bolts and the lugs and set-screws on pipe supports.

The sides of greenhouses are usually five or six feet high, but they may be as high as eight feet when considerable head room and abundant side ventilation are needed, as is true in growing sweet peas. As most benches are now placed away from the side-walls, only sufficient height is necessary to allow workmen to pass easily along side-walks.

62. Eave-plates and gutters.—In most commercial houses, gutters are not used. They are heavy and exclude much light. To eliminate shade is very essential and the eaves are made of as light a material as possible.

In houses of the U-bar type, sash-bars function as rafters, and as curved glass is used at the eaves, there is nothing to cause shade. In other types, metal angle-iron is used at the eaves (Fig. 9, left). This metal conducts heat rapidly and it is said that no icicles will collect to cause shade in the houses. In some forms of pipe-frame houses, a thin, metal strip is screwed to the sash-bars on the outside of the house at the eaves, and the glass of the side-wall and that of the roof rest firmly on this metal. When wooden walls are used, a beveled eave-plate of two-inch lumber is placed along the top of the posts and side-walls, and on this the sash-bars of the roof rest.

63. Roof construction.—One of the principal things in roof construction is that it shall be of such an angle at the gutters that all the light possible will be trapped.

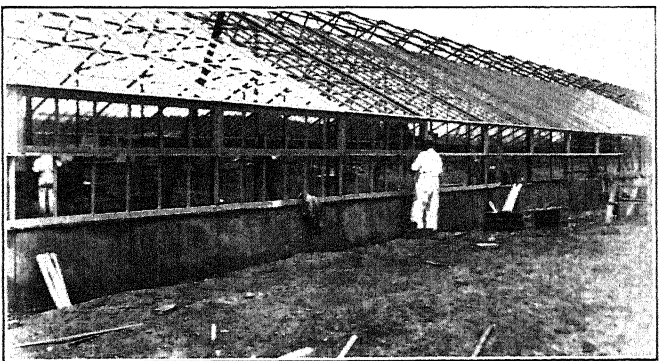
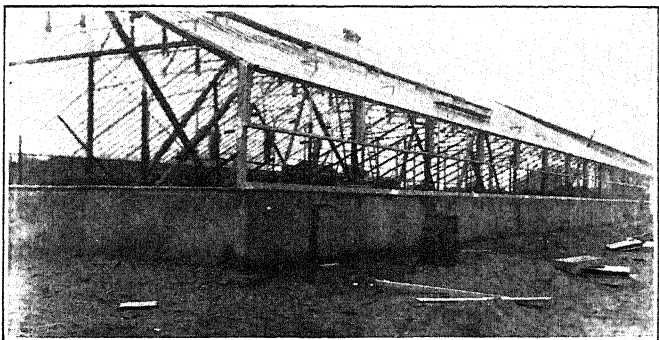
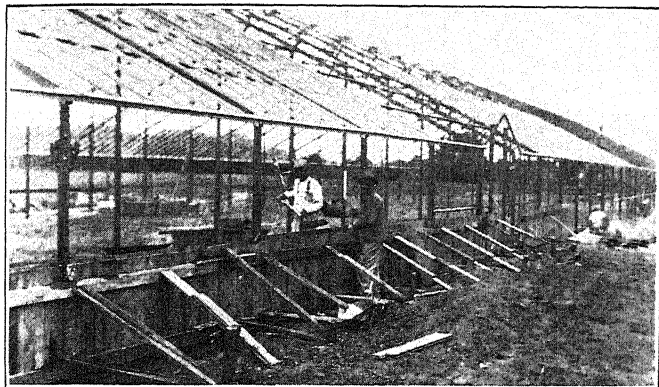


FIG. 13.— Upper. Placing the cement in a "curtain-wall." Middle. The forms removed showing the finished side-wall. Lower. Placing the side ventilators and sash-bars.

As has been stated, best light conditions are obtained when glass is nearly at right angles to the sun's rays. It is important, therefore, that the roof be not too flat. In even-span houses, an angle of from thirty-two to thirty-five degrees is desirable, and in uneven-span houses, the angle of the southern slope is from twenty-eight to thirty-two degrees and that of the northern slope about forty-five degrees. The size of the angle is influenced somewhat by the width of the house. If glass roofs are too flat, there is an increased tendency toward drip in the houses.

Constructing the frame. — In constructing the roof, the ridge is first placed at such a height as will give the desired angle to the roof. If rafters are used, they are first put in place, iron supporting columns are placed and purlins attached. The distance between purlins will vary according to the width of the span of the roof. They should be placed closely enough so that there will be no sagging of the sash-bars when the glass is placed. The frame is now ready for sash-bars. These are carefully spaced to allow the size of glass selected to fit evenly and easily without pressure. If top ventilators are used, a header should be placed at the proper distance from the ridge, and the upper end of the sash-bars rests on it. Otherwise, they are attached to the ridge.

Size and quality of glass. — For most commercial houses double thick "B" quality glass is used. This quality of glass is also known as "seconds." First quality glass is much more expensive and does not improve the light conditions sufficiently to offset the increased cost. The standard size of glass for commercial houses is sixteen by twenty-four inches, although glass of a larger size is sometimes used.

Laying the glass. — The frame is now ready for the glass.

A good grade of putty is laid evenly and smoothly on the rabbets of the sash-bars. Expert glaziers will lay this very rapidly by taking the putty in each hand and rolling it along either side of the sash-bar. After a little practice in handling putty, there will be no trouble with its sticking to the hands. In laying glass it is always better to begin at the eaves and lay the first row across the roof. By doing this, the sash-bars are kept correctly spaced. The glass is laid with the bevel side up, so the moisture which accumulates on the interior of the glass will be drained towards the sash-bars, where there are special drip-grooves to receive it. To avoid slipping, care must be taken that this first row of glass be held firmly at the lower edge. If wooden eave-plates are used, number seven, three-quarter-inch brads are driven firmly into it, in a straight line, and the lower edges of the glass rest against these brads. If metal eave-plates are used, the brads are driven into each side of the sash-bar and sufficiently low so that when the glass is in place, each corner will rest against the brads and slipping will be prevented. It is better to drive these basal brads into place before the putty is laid. By doing this, the lower edge of the glass is brought to an even line.

After the first row of glass is laid, more brads are driven into place on either sash-bar, about a half-inch above the lower edge of glass. Pressure should be put on the glass so that all surplus putty may be squeezed out, and the glass brought firmly in contact with the sash-bar. If the glass is large, a second brad is driven in firmly one-eighth of an inch from the top. This allows a lap of one-eighth of an inch between panes of glass, which is sufficient to exclude all air and water. If a wider lap is made, dirt and soot will collect and the light conditions in the houses will not be of the best.

The second row of glass should be placed entirely across the roof, so that the sash-bars will again be properly spaced, and this second row is held in place with brads the same as the first row. In laying this second row, care should be taken to have the bevel of glass the same as before, otherwise there will be quite a space between the two panes of glass, admitting much air and water. Row after row of glass is laid, and outside or inside stagings are built to facilitate the work as it progresses towards the ventilators or the ridge.

In estimating the width of the roof, care should be taken that it be just wide enough to take whole panes of glass. This avoids the cutting of panes at the ventilator or the ridge, which means a saving of both time and glass. If it is not possible to have the roof of the right width to accommodate a full pane of glass, it should be of such a width that a half pane may be used. In handling the glass, great care should be taken to keep it clean, and especially free from putty, the marks of which are difficult to remove, and if not removed, it detracts from the amount of light admitted.

After the roof is glazed, all surplus putty is scraped off. In removing putty, it is important that the pressure of the putty knife be brought against the space between the glass and sash-bars. In this way all spaces are filled. After the putty is removed, the glass is cleaned and the sash-bars are ready for painting.

Painting the roof. — In painting the roof, all exposed areas of putty should be covered. All sash-bars should have a priming coat of thin paint before the putty is laid, otherwise the oil from the putty will enter the wood, causing the putty to crumble and the glass to loosen. This crumbling also occurs if the putty is not carefully

covered with paint after the glass is in place. An accumulation of moisture in the putty also causes it to crumble and thus loosens the glass, which often slips down, admitting cold air and water to the interior of houses. Painting prevents crumbling of the putty and makes the roof more durable. After the first coat has dried, a second should be given. Great care is required in the painting of the inside of the house, for it is exceedingly difficult to cover the putty without getting paint on the glass.

In glazing greenhouses, the glass is sometimes butted instead of lapped. It is more difficult to reset butted glass, for it is almost impossible to find two panes of the same dimensions. There is also more drip from roofs where glass is butted. Light conditions, however, are somewhat better, for in houses glazed in this way, no sunlight is excluded because of the double thickness of glass at the lapped area, nor will an accumulation of soot or dirt collect between the panes at this point. Upright glass on sides and gables of houses is usually butted, for slipping is not so liable to occur and light conditions are better.

64. Interior supports and truss-work. — It is important that roofs of greenhouses be strongly supported. This is necessary not only to hold the roof up, but to hold it down as well. The suction force of a strong wind passing over the ridge of a large house is considerable. It is therefore necessary that all columns used for supporting roofs be firmly embedded in grouting at the base. The size of these columns varies with the size of the house, but they are seldom over two and one-half inches in diameter. Cross-ties of smaller piping serve to strengthen these columns. The number of rows of columns will depend also on the width of the house. Angle-iron columns

are sometimes used in place of pipe columns (Fig. 9, center).

As these columns cast considerable shade, which is objectionable, they have been eliminated in many houses and span-trusses used to support the roofs. When these iron trusses are attached to iron, the results are highly satisfactory, but when attached to wood, as in the early forms of truss-work, decay of the wood quickly weakened the supporting strength of the truss. Where many trusses are used, however, and these are of small dimensions, as they usually must be in order not to detract from the light of the house, much time must be spent in keeping them adjusted. The cost of painting is also considerable, and these items should be taken into consideration in estimating the value of a house.

65. Ventilators — Ventilators are usually placed on each side of the ridge and frequently on each side of the house below the eaves. Sometimes the side ventilators are below the glazing-sill, in which case panel ventilators are often used. They are advantageous when benches are placed against the sides of the houses, for cold air does not blow directly on the plants. If the fresh air passes through the heating pipes which are along the sides of the houses and below the benches, the atmosphere is modified before it comes in contact with the plants. Orchid houses, which require an abundance of moderately heated, fresh air, are frequently ventilated in this way.

When violets and sweet peas are grown, there should be wide ventilators below the eaves, and it is generally considered that such should be in carnation houses, but in rose houses such ventilators are never used. They are usually wide enough so that one and one-half panes of glass, sixteen by twenty-four inches, are used.

For the roof ventilation it is considered best to have a row on either side of the ridge. It may not be necessary to use both, but in case of a severe wind, the row on the side from the prevailing wind could be raised and severe drafts in the houses avoided.

Roof ventilators may be continuous or intermittent. Many of the best growers believe that intermittent ventilators are preferable because they equalize the temperature better as the air is admitted. The warm air rises from the pipes and strikes the glass of the permanent roof between the ventilators, and as the cold air is admitted, it is warmed by the hot air on three sides of the vents. With continuous ventilation it is all admitted in a continuous line.

Whether continuous or intermittent systems are used, the ventilators should not be very heavy, for they must be easily and quickly raised without severe jars to the roof and ridge. They are usually not over thirty inches wide, but this varies with the width of the houses.

There are various types of apparatus used for operating the ventilators. The principal factors of a good apparatus are that it must be strong, so that comparatively long areas of ventilators may be raised quickly and easily, and the section of glass at the farthest end of the system must be opened and closed just as readily as the section next to the controlling shaft. The apparatus should be simple and easily adjusted. It should also be of sufficiently small dimensions so that it does not prevent the sun's rays from striking the plants. Each section should be carefully adjusted so that all will close tightly at the same time. Self-oiling, closed-gear, ventilating shafts are now used in many large ranges.

In high houses, when the night watchman cannot see the

ventilators, it is often essential that he know how much air he has on the houses. This is determined by means of a leaded weight tied to a string which falls beside one of the iron columns. On this column there is marked a graded scale which indicates the number of inches the ventilators are open.

66. Interior equipment. — The benches or beds vary according to the crops grown. In modern ranges where many potted plants are grown, there is now a preference for concrete benches. Carnations grow better in benches built of wood, although excellent blooms have been produced in concrete benches. A solid concrete bed with tile bottoms also produces excellent results. Roses, violets and sweet peas are usually grown in solid beds with concrete or board sides.

Benches and beds are not placed directly against the wall in the most modern ranges, for there the atmospheric conditions are not as favorable for plant growth. Walks are usually made along the sides. The width of benches and beds varies with different crops, but they are rarely over five feet wide, that being a convenient width for working. Some rose-growers prefer to have the beds but three feet wide, accommodating but three rows of plants, as it has been observed that the plants in the interior of beds are not as productive as those on the outside.

The width of walks varies in different ranges. Much depends on the use which is to be made of them. If the walks are to be used as a thoroughfare, they should be at least two feet wide, but if used simply for the care of crops, walks fifteen or eighteen inches wide are sufficient. Usually in large ranges the center walk and outside walks are wider than the others.

Water pipes should be conveniently arranged, with

plenty of faucets to facilitate the watering of plants quickly and thoroughly. It is a waste of time to drag long reaches of hose about a range and is detrimental to the hose as well.

COST OF CONSTRUCTION, EQUIPMENT, AND MAINTENANCE OF THE RANGE

A natural and very vital question regarding greenhouse construction is the probable cost of building a new range. This information is especially important for the young man just starting in business. His capital is probably limited and he should know before beginning to build, the approximate cost. This is often extremely difficult to determine for there are so many varying factors in greenhouse construction that it is hard to decide as to selection of materials for construction and equipment.

67. Size to build.—One should first decide on the probable size of the range. This should be governed to a considerable degree by the probable output. The range should be large enough to produce an income sufficient to support the family of the grower, and an income sufficient to make its management worth while. There should be an intimate relation between the size of the range and the labor necessary to maintain it. For example, there are a few men, such as the night fireman, the day fireman and the foreman, who are necessary on a range of perhaps forty thousand square feet. If the range is increased to eighty thousand square feet, no more labor of this kind would be necessary. Often it may be that the addition of but one or two laborers would be needed for the additional glass, and if a larger range can be run with but little more labor, surely it is economy to build

the larger range, even if it necessitates a larger expense at first.

Usually in planning a range, the boiler capacity is sufficient for several additional houses. If this is not practical, the boiler room should be large enough to accommodate other boilers. They may be added in batteries. That is, they may be so arranged by valves, that during mild weather but one boiler may be run. During colder weather, the full capacity of the boilers may be utilized. Often it is wise for the young grower to begin with a limited area of glass, but there are a few fundamentals, such as boiler houses and other service buildings, which should be large enough in the beginning to accommodate a larger area of glass, for it is expensive adding to them after they are once built.

68. Cost of construction.—The cost of construction varies with the method selected. There are some methods of building greenhouses which are so expensive as to make them out of the question in commercial ranges. There are so many varying factors in building a range that it is exceedingly difficult to estimate the approximate cost. Two ranges are seldom built alike, and the varying cost of grading different areas, variations which are brought about because of different sized houses, and differences in minor details of construction, make the problem of the determination of cost a complex one.

The all-wood house is usually considered to be the cheapest. When large ranges are built, however, it is doubtful if an all-wood house can be built very much cheaper than a pipe frame or semi-iron type. Cheap houses can, of course, be built, but they are seldom satisfactory.

An all-wood house may probably be built at as low a

figure as sixty cents a square foot of ground surface covered, but greenhouse men, who are looking for a permanent construction, consider this false economy. The price will, of course, vary considerably with different grades of wood, glass, and other material used, also with the locality. Greenhouse material is not made by the ordinary lumber dealer or saw-mill, and it may be necessary to transport it quite a distance. In that case, the cost of construction must necessarily be increased. It must not be considered that a low first cost is of necessity the cheapest, for unless the material be durable, it is not economy to purchase it.

Iron-frame houses are naturally somewhat more expensive than all-wood houses, but their increased durability usually makes them cheaper in the end. It is estimated by builders of these that the approximate cost of this form of construction is from seventy to seventy-five cents a foot of ground surface covered. This cost, of course, again depends in a large measure on the quality of material used, and the character of the fittings in the houses.

69. Contract vs. home construction.—Often it is cheaper to contract with a professional builder for the construction of the range. This depends somewhat on whether or not the owner has a mechanical mind, and on the workmen on the range. If the framework be at all complicated in its construction, it is without doubt better for the manufacturer to superintend the erection of the superstructure. If one has plenty of help available, it is often cheaper for the owner to do the grading and building the foundations, and then contract with some firm for the erection of the superstructure. If there are expert painters and glaziers employed constantly about the range, it will be cheaper to contract only for the erection of the frame and sash-bars. Men who are constantly employed

at this work, however, can accomplish a great deal in a comparatively short time, so that in many cases it is cheaper in the end to include the painting in the contract.

In building a medium-sized, wooden range, or for the same sized, simple, iron-frame house, it is, without doubt, cheaper for the owner to build his own house. When contract work is to be done, specifications for the same should be very clear and concise. They should state definitely when the work is to be finished, the quality of material to be used, and in general, every detail of construction and heating should be so carefully worked out before the contract is let, that no question can arise later as to just what is required.

70. Cost of equipment. — The first cost of construction, with the boilers, piping, and benching, is by no means the only cost. Often this fact is overlooked by the inexperienced man. In construction there is, of course, a demand for many tools, such as hammers, saws, squares, planes, paint brushes, trowels, putty knives and articles of a like nature; and whether the work of construction is done by contract or not, there is a constant demand for these articles about the range. The first expense of them is considerable. About most ranges there must be horses, various plows and harrows for preparing the soil, and carts, wheelbarrows, and the like, to transport this soil to the benches or beds.

Unless one has grown his own stock, the first expense of plants for the houses is considerable. Fertilizers, both for the compost and later for top-dressing, and for liquid manure, are expensive, and there should be a sufficient sum estimated in the first cost to cover the expense of this fertilizing material. In rose houses, a manure tank is essential, and an engine and pump should be provided for

forcing the liquid manure over the range. The size of the tank and also that of the engine and pump varies with the size of the range, and only an approximate estimate of the cost of these can be given.

To arrive at the approximate cost of constructing a house, a definite proposition may be valuable. We will, therefore, estimate the cost of constructing a medium-sized range of carnation houses. As many growers now prefer to have all their plants under one roof, rather than have several houses, an up-to-date, large, iron-framed house of truss construction will be the basis of this estimate. Cheaper and smaller houses could, of course, be built, but these figures may form a basis for comparisons.

71. An estimated cost of construction, equipment, and maintenance of a modern range of greenhouses. — These figures were obtained from a reliable commercial grower who has recently built and equipped a new range. Estimates were also furnished by construction firms, with little variation from these figures.

Construction of range complete :

Estimated cost of constructing foundations and super-structure, with heating pipes, for a greenhouse covering 24,000 square feet	\$13,000
Boilers of sufficient capacity to accommodate one other house of equal size, and piping for same	3,000
Service building with cellar, thirty feet by forty-four feet, of concrete foundations, and concrete blocks above grade	3,100
Chimney (round), seventy-five feet high, of common, hard or radial brick, lined part way with fire brick	1,000
Excavating for foundations, boiler room and other grading	1,500
"Pecky" cypress for benches	2,000
	<hr/> \$23,600

The cost of the above range complete is ninety-eight cents a square foot of ground area covered. A range consisting of two houses each 343 feet 4½ inches in length, and 35 feet 4 inches in width, could be built for approximately the same figure. Each house would contain 12,131 square feet, or a total area in the range of 24,262 square feet. These houses are of pipe-frame type, built on pipe posts embedded in concrete piers, with a four-inch curtain-wall.

Equipment for range:

25,000 carnation plants, at \$4 00 a hundred	\$1000
Soil for benches, and its preparation	600
400 feet hose for range	75
Thermometers	9
Wire for supports	10
Tools, wheelbarrows, spades, etc.	75
Boxes for shipments	100
Insecticides	35
Fertilizers for top-dressing	100
Sundries	100
	<hr/>
	\$2104

The cost of equipment is about nine cents a square foot of ground area covered.

Maintenance:

Wages of foreman	\$1000
Wages of night fireman	720
Wages of day fireman and caretaker	720
Wages of laborers	660
Coal 150 tons a year; approximate cost	750
Water tax	50
Electric lighting	30
Ice	100
	<hr/>
	\$4030

The cost of this maintenance is sixteen and one-half cents a square foot of ground area covered.

Other expenses — In the maintenance and up-keep of a range, other factors must be considered. Among them are, the interest on capital invested, town taxes, and depreciation in value of the property. Land values should also be considered.

For a range such as that mentioned, at least ten acres would be necessary to provide for future increase and soil for the greenhouses. Fifteen or twenty acres would not be too large a land area for an important range. Too many builders establish their ranges on too small an area. However, estimating ten acres as the amount of land necessary, this would probably necessitate an expenditure of \$500 to \$1500 an acre, or a first cost of \$5000 to \$6000. A reliable grower states as follows:

"One who is to start in business in a wholesale way should go out of town far enough so that he can get a larger area of land for a given amount. I consider fifteen or twenty acres enough. Land in this vicinity may be bought for \$500 per acre, which I think as much as a wholesale grower should pay."

In estimating the running expenses, therefore, we will estimate the land value at \$7500. Our estimate would then be:

Interest on capital invested in greenhouses, equipment and land, at 5 per cent	\$1660.20
Taxes on greenhouses and land at one-half per cent	155.50
Annual depreciation at 5 per cent on greenhouses and equipment	1285.20
Annual maintenance	4030.00
Annual running expenses	\$7130.90

Income. — The expected returns for such a house are difficult to estimate, for much depends on the market prices, which are variable year by year: also on the

method of marketing, whether this be at wholesale or retail prices. A conservative estimate of the number of flowers from each plant would probably be about twelve. This would make the annual production of blooms from twenty-five thousand plants, 300,000. If the average price of these, including cost of transportation, be three cents, the income from the house described would be about \$9000.

Growers differ in their estimates of the number of flowers which should be produced by each plant, also regarding the average wholesale price received for the same. Letters sent to many growers brought widely different estimates. One New York grower, who has kept careful figures of yield and returns for many years, writes as follows: "Fifteen flowers to the plant is considered high, and a production of ten flowers is much more general. From actual figures taken on our range, from ten to fifteen flowers to the plant is as high an estimate as can be given. I recently averaged the prices we received for the last ten years, and found that the average was about three and one-half cents. I think three cents, or, at the lowest, two and three-quarters cents, is a fair estimate."

Other growers consider fifteen flowers to the plant a low yield, and an average price of three cents a high estimate.

The average yields of roses, violets and other cut-flower crops may be determined in a similar manner. This subject of cost of production and its relation to the income offers a wide field for investigation.

CHAPTER VI

HEATING THE RANGE

GREENHOUSE heating is a problem which requires very careful study. Much thought and investigation has been given the subject, still, in the opinion of the best growers, much remains to be learned.

72. Difficulties in heating greenhouses uniformly. — Greenhouses are exceedingly difficult structures to maintain at a given temperature because their character makes them especially susceptible to variations from outside heat or cold. Conditions are such in greenhouses that a variation of a few degrees in temperature may so retard the development of the plants, that a great financial loss to the grower is the result. If the change of temperature is great, it means death to the plants. Greenhouses as now constructed are so much larger than in former years that it has become necessary to install systems of heating which will be under perfect control at all times, and a uniform temperature thus maintained.

73. Methods of heating. — Commercial ranges of the present day are heated by steam or by hot-water. In the larger number of cases, steam is used.

74. Comparative merits of hot-water and steam heating. — In the early history of the industry, practically all greenhouses were heated by hot-water. The ranges were small and hot-water was found to be more economical. Hot-water heat has always been considered to be less

intense than steam heat and to resemble more nearly the heat from the sun. The plant growth resulting from hot-water heat is considered by many to be more healthful and vigorous. In the early ranges, large pipes were used for hot-water heating, and the circulation of water was necessarily slow. Large boilers were also necessary to heat the bulk of water required. With the construction of larger greenhouses, there arose a demand for a better method of heating, and steam came into more general use. This continued the more popular for many years. With recent improvements in forced circulation of water, however, so that smaller pipes are used, hot-water heating has again come into favor with a number of large growers.

Taft in his book on "Greenhouse Construction" writes: "The following are among the claims made by advocates of steam for their favorite heating system: (1) a lower first cost; (2) ability to maintain a steady temperature; (3) readiness with which the temperature can be raised or lowered if desired, (4) economy of coal consumption; (5) ease with which repairs can be made.

"The hot-water men admit that these claims hold to a large extent against hot-water in four-inch pipes, but they contend that the men who make these claims have made no comparison with modern, well-arranged hot-water systems, and that, under proper conditions, the latter system is preferable. Those who favor hot-water claim for that method that at the most, only the first claim of the steam men will stand, and that on the other points, hot-water can make as good, if not better, showing."

Both methods have been wonderfully improved since the above was written, and while it would still be diffi-

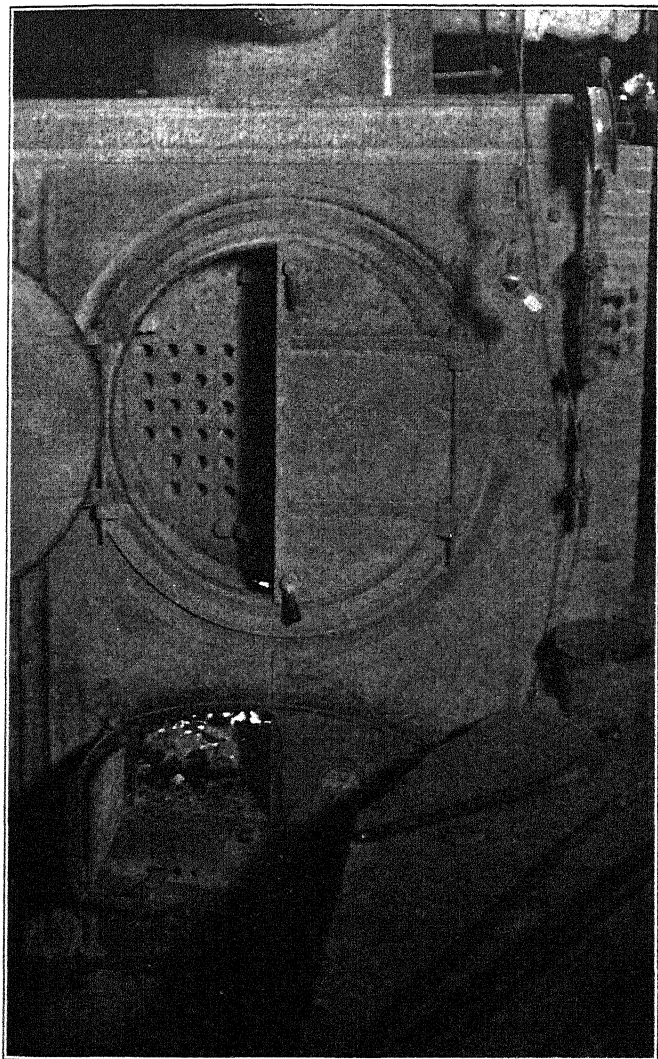


FIG. 14. — A cast-iron, horizontal, tubular boiler.

cult to convince many large commercial growers that it would be more economical and also more beneficial to plant growth to use hot-water instead of steam, in a number of ranges where hot-water systems have been installed, the results seem to favor that system.

75. Controlling the heat. — With either steam or hot-water, it is necessary to have the heat well under control, and this is possible only by the use of many valves. These valves should be so placed that they can be used readily, for it is often necessary to turn heat on or off at a moment's notice. This is especially true on days when there are frequent "sun bursts," followed by periods of cloudiness. It has been asserted by advocates of steam heating that hot-water cannot be so quickly and readily heated or cooled as steam. To a certain extent this is true, but with improved systems of water under pressure or in forced circulation, smaller pipes are used, and these heat or cool almost as quickly as steam pipes when the flow is checked by valves.

76. Boilers. — In most modern ranges of large size which are steam-heated, cast-iron, horizontal tubular boilers are used (Fig. 14). They are of varying horsepower, as required by the size of the range. The boilers should always be large enough to furnish heat for a larger glass area than is actually in use. Most large ranges have the boilers arranged in batteries so that if an accident occurs to one boiler, it may be easily disconnected and the range sufficiently heated by the other boilers. Some growers prefer sectional boilers, and these are manufactured for both steam and hot-water (Fig. 15). Tubular boilers are necessarily of large size. Sectional boilers are, therefore, better adapted for use on small or medium-sized ranges. If additional heat is needed be-

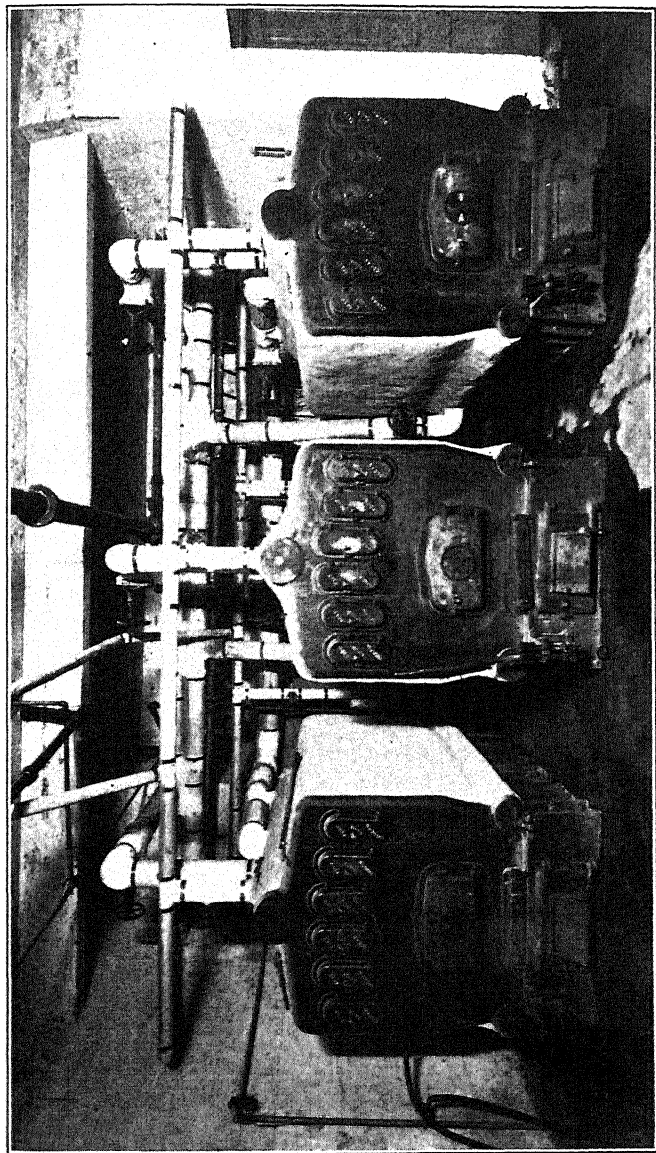


FIG. 15. — Sectional boilers arranged in a battery.

cause of increased glass area, a second sectional boiler may be installed.

77. Fuel. — The selection of fuel depends largely on the location and the size of the range. Different kinds of fuel are less expensive in some sections than in others. When a cheap grade of soft coal is used, it is most frequently burned by forced draft. This is by a blower which increases the rapidity of combustion.

78. Arrangement of supply pipes. — In the older systems of steam heating, it was customary to have a large "flow-pipe" which went to the farther end of the house and there branched to supply various return coils. In up-to-date ranges, this method is seldom used. In the old systems, large flow-pipes were located near the roof, with the result that much heat was lost unless the pipes were packed in asbestos covering. This was because the heat was where it was not needed. Then again, much shade was cast in the house by these flow-pipes. The pipes are now so arranged that the steam, as it enters the house, is dispersed through many small coils until it reaches the farther end of the house. It then comes into a trap, in case the end of the house is not high enough to allow condensed steam to flow back to the boiler by gravity. One and one-fourth inch pipes are used for the flow and two-inch pipes for the return. If there are several large houses, the steam leaves the boiler through a large pipe. This extends through the connecting houses, and as it passes each house, the steam necessary to heat that house enters the small pipes.

In a large, commercial, rose establishment which is heated by steam, three one hundred and sixty-three horsepower boilers are used to heat four houses, each of which is five hundred feet long and forty-two feet wide. These

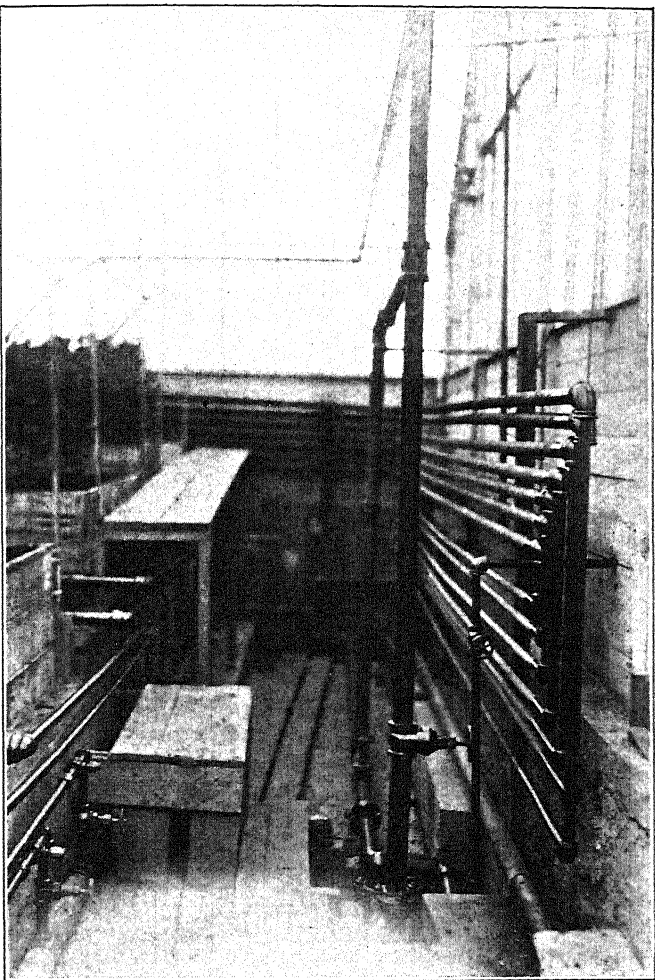


FIG. 16. — Arrangement of pipes at the end of a rose house. On the right and left, one and one-quarter inch coils are reduced to three-quarter inch. In these are placed the valves which control the heat. In the lower foreground is a Squires trap, and the upright pipe from this carries the water from the condensed steam back to the boilers.

boilers have sufficient capacity to heat additional houses if needed. A six-inch main from the boilers furnishes steam for the three houses which are farthest removed, and a four-inch main furnishes steam for the other house. This main is of sufficient size to heat another similar house. Twenty-four coils of one and one-quarter inch pipe are distributed through each house as follows: seven on the north wall, five on the south wall, and one on each side of the six beds. This piping furnishes sufficient heat for the coldest days, and it is seldom necessary to use more than seventeen coils. As these coils approach the farther end of the house, the one and one-quarter inch coils are reduced to three-quarter inch. In these are placed the valves which control the heat (Fig. 16). This economizes the expense, for the cost of one and one-quarter inch valves is much higher than the cost of the three-quarter inch valves.

This reduction in size also equalizes the heat better. It retards the passage of steam through the pipes so that the steam is practically all condensed as it reaches the end of the coils. At the northeast corner of the house the pipes enter a Squires one and one-half inch trap and as this trap operates, it lifts the water to the top of the return pipe, which extends to an elevation of nine feet. From here it returns by gravity, first through a two-inch pipe to the head house, and then in a four-inch pipe to the boiler. The owner states that this system has given perfect satisfaction.

79. Location of other pipes. — Upon the arrangement of the heating pipes in greenhouses depends very largely the owner's success or failure in growing his crop. One must know the native environment of the species with which he is working, and then endeavor to imitate as

nearly as possible the natural conditions which favor its growth. Violets, for example, require a cool, moist soil, therefore they grow best in solid beds. The heating pipes in violet houses should be placed as far from the plants as possible. Sweet peas also grow best in cool, moist soil. One of the largest houses devoted to sweet pea and violet culture is four hundred feet long by forty-three feet wide. The owner has all heating pipes along the sides. The heated air rises until it strikes the roof at the eaves, then continues to the ridge, thus making a blanket of warm air over the plants, and giving sufficient protection from injury by cold, and at the same time allowing a cool condition of the soil. Fungous diseases are thus kept in check and the heating conditions more nearly approach those from the sun's rays.

In carnation houses, the larger part of the heating pipes are placed along the sides of the houses. The best growers usually have one pipe underneath the benches. This pipe is so valved that it may or may not be used. It is used in severe weather or when cloudy conditions prevail, so that the soil water does not dry out readily. Underbench heat, however, is not satisfactory even in carnation culture, for the bottom soil dries out before the top soil shows any indication of dryness, and the roots of the plants are thus injured. Chrysanthemums require similar temperature conditions to those of carnations, and intense heating conditions should be avoided, for chrysanthemums are distinctly cool crops.

Roses thrive best in warm soil and in a warm, moist atmosphere. In rose houses the heating pipes are usually distributed along the sides of the benches. They are rarely placed underneath.

80. Determination of radiation surface. — In an ad-

dress before the students in floriculture at the Massachusetts Agricultural College, F. J. Elder, then heating engineer for Lord & Burnham, considered this topic in a clear, logical way. He spoke as follows:

"A greenhouse is, without doubt, the most difficult of all structures to heat, and is, it might be said, the least responsive to scientific calculation to ascertain the required quantities of radiation. This is due to the great susceptibility of a greenhouse to the cooling effects of winds. If outside air were at all time quiet air, the heat loss per square foot of exposed surface would be constant, notwithstanding the fact that the openings between the lapped lights of glass are not at all of the same size. Excepting sheet iron only, glass is, of all building materials, the greatest conductor of heat, and all greenhouse radiation must be figured in ratio to the exposed glass surface or its equivalent in other exposed surfaces. The ratios following have been used by Lord & Burnham Company for years, and have given satisfaction."

TABLE OF FACTORS FOR FINDING THE NUMBER OF SQUARE FEET
OF PIPE SURFACE REQUIRED TO HEAT WITH HOT-WATER TO
DIFFERENT TEMPERATURES IN GREENHOUSES WHEN THE OUT-
SIDE TEMPERATURE IS AT ZERO

- "For 70° to 75° divide square feet of glass and equivalent by 1.8.
- "For 65° to 70° divide square feet of glass and equivalent by 2.28.
- "For 60° to 65° divide square feet of glass and equivalent by 2.62.
- "For 55° to 60° divide square feet of glass and equivalent by 3.

- “ For 50° to 55° divide square feet of glass and equivalent by 3.46.
- “ For 45° to 50° divide square feet of glass and equivalent by 4.
- “ For 40° to 45° divide square feet of glass and equivalent by 4.67
- “ For 35° to 40° divide square feet of glass and equivalent by 5.5.”

81. Explanation of the table. — “ From the use of such a list of divisors it will appear that greenhouse heating, as practiced, is a rule of thumb business. The list of divisors is not, however, entirely a rule of thumb, but it amounts to nearly the same thing, inasmuch as it is a fact that in the derivation of the formula from which the divisors are obtained the premises are not all absolutely correct. Therefore, the conclusion can hardly be true to all cases.

“ The formula is $\frac{(T - T')G}{(150 - T)^2} = R$, where T equals the temperature required in a greenhouse, T' equals the coldest outside temperature, G equals glass and equivalent exposure, 150 equals average temperature in degrees of water in pipes, 2 equals the B. T. U.¹ given off per square foot of pipe surface per hour per degree of difference between the temperature of the air, and that of the water in the pipes, and R equals the required number of square feet of radiating surface. This formula is constructed on the theory that every square foot of glass surface loses 1 B. T. U. per hour per degree of difference

¹ A B. T. U. is a British Thermal Unit, the standard of heating measurement. It represents the quantity of heat required to raise the temperature of 1 lb. of water 1° Fahr.

between the inside temperature and the temperature outside, and that every square foot of pipe surface effuses 2 B. T. U. per hour per degree of difference between the temperature of the water in the pipes and the air surrounding the pipes. It is evident that if one square foot of ordinary vertical window glass surface loses 1 B. T. U. per hour per degree of difference between the inside and the outside temperatures, one square foot of greenhouse roof surface with its lapped glass, between the lights of which the wind blows at will, and which surface is nearer horizontal than vertical, will lose heat at a considerably greater rate. Also, horizontal pipe coils do radiate heat at a rate of 2.25 B. T. U. and upward per square foot per hour per degree of difference, and the rate may be taken as 2 B. T. U. without appreciable error, and finally, the average temperature of the pipes is usually 10° or 15° higher than 150° , and on demand it may be brought to an average temperature of 180° . So it is evident that the formula is constructed from data which are not absolutely correct. Nevertheless, the results obtained are to a degree constant.

“The quantities of radiation produced by these divisors are large, and assurance is felt that the temperatures required will be maintained through eight to ten hours of inattention to the fire during the night, during which time the fires are banked and provided with very little draft. It is owing to this feature, namely, that hot-water heaters generally get no attention at night, that large pipes are preferable to small pipes for greenhouse heating by gravity circulation of hot-water. These large pipe systems, contemptuously called ‘water logged’ by manufacturers of different devices, which are calculated, or are represented to produce the same or a greater amount

of heat with a lesser consumption of coal, will maintain temperatures during the night and toward morning, far better than a small pipe system can.

“ It has been stated that the susceptibility of green-houses to cooling winds makes them hard to heat. The actual loss of heat through laps between the glass is next to impossible to calculate. In the heating of dwelling houses, hospitals, offices and all such buildings, engineers calculate very closely the number of air changes per hour and make proper provision for the same. In greenhouses the number of changes of air per hour, whatever it might be, is dependent first on the wind velocity or pressure, on the roof pitch, on the shape of the roof, on the amount of lap of the glass and on the size of the openings between the laps of glass. The size of these openings, in turn, depends upon the width of the glass used. The wider the glass used, the greater the ‘ sag,’ that is, the greater the openings between the lights. Four widths of glass are used, twenty-four, sixteen, fourteen and twelve inch, although sixteen-inch may be taken as a standard, as it is now being used almost exclusively in the best houses. Fourteen and twelve-inch glass are seldom used.

“ It has been explained that the number of changes of air per hour are hard to determine. Nevertheless, the heat loss due to this cause is high, and for this reason it is comparatively easier to heat a large house than it is to heat a small house, or in other words, less radiating surface is required per square foot of glass for a large house than is required per square foot of glass for a small house. The proportion of glass to cubic contents is not true for all sizes and shapes of houses; with houses of the same general shape, the same height of eaves and the same roof-pitch, the amount of cubic contents is higher in ratio

to the glass in large houses than in small houses. This difference in the ratio of glass to cubic contents is easily shown by placing two houses of the same width and roof-pitch together in ridge and furrow fashion, then comparing the glass and cubic contents of the single house to the glass and cubic contents of a house of twice its width.

“There is another fact that upsets an attempt at exact calculation of radiating surfaces in greenhouses. This is, that as the atmosphere in a greenhouse is usually humid, when the outside temperature is in the neighborhood of zero, a sheath of ice covers the glass. This sheath stops the openings between the laps and also changes the rate of conduction through the glass so covered. It is not possible to say at just what outside temperature this sheath forms, as the formation of this ice is obviously dependent on the degree of humidity inside the house, the temperature in the house and the proximity of the radiating surface to the glass.”

82. Comparison of amount of radiating surface required for steam and for hot-water. — “In all calculations for the radiation of dwelling houses, it is usual to consider the amount of hot-water radiation required, and the amount of low pressure steam radiation required, as being equal to the ratio of 1 to .6, or in other words, where one hundred square feet of hot-water radiation would be used, sixty square feet of low pressure steam radiation would produce the same results. In the heating of greenhouses, it has been found that one linear foot of three and one-half inch cast-iron pipe in hot-water heating will produce the same results as one linear foot of one and one-quarter inch low pressure steam pipe, and the ratio of hot-water surface to low pressure steam surface in greenhouses is, therefore, 1 to .4, one linear foot of three and

one-half inch pipe being equivalent to one and five-hundredths square feet of surface, and one linear foot of one and one-quarter inch pipe being equivalent to forty-three hundredths square feet of surface. This difference of the comparative values of hot-water and steam heating surfaces is due to the fact that greenhouse heating systems are called on for their very hardest work at night, and dwelling house conditions require the most heat in the daytime; and again a greenhouse hot-water plant gets little or no attention for hours at night, while a steam heating system requires a night fireman. To be brief, there is less difference in night and day temperatures of steam pipe than there is in night and day temperatures of hot-water pipe."

SYSTEMS OF GREENHOUSE HEATING

- | | | | | |
|--------------------|---|--|---|--|
| A
Hot-
water | { | a. Open tank gravity | { 3½" cast-iron pipe.
2" wrought-iron pipe. | |
| | | b. Closed tank or pressure | { safety valve
mercury seal. | |
| | | c. Forced circulation | | |
| | | 1. Water heated in cast-iron boiler | { Propeller driven by electricity,
centrifugal or rotary pump driven | |
| | | 2. Water heated in converter or feed water heater. | { by steam, electricity, gas or oil engine; piston pump driven by steam | " rust caulked " joints or screwed joints. |
| | | 3. Water heated in tubular water boiler | { | |
| | | a. Low pressure with gravity return | | |
| | | b. Low pressure with return by steam trap. | | |
| | | c. High pressure at boiler, with reduced pressure in greenhouses, and pumped return. | | |
| | | | | |

83. Open tank gravity hot-water heating. — "It has been mentioned that there are over-bench and under-

bench heating systems. However, the whole of the radiation, or even the bulk of it, is seldom placed overhead, although the mains are often carried overhead on roof supports. The coils are fed at the far end of the greenhouse, and all coils in the system are return coils. This plan is much used in the Western States, but not much used in the East. Its principal virtue is that a deep pit is not necessary for the heater, and as there are many sites where it is not possible or practicable to secure a boiler cellar of reasonable depth, because water is near the surface, or rock formation makes it too expensive to excavate, this system is at times a matter of necessity. The great objection to the overhead system of hot-water heating is that it is difficult to heat the greenhouse evenly, because the far end of the house is bound to be warmer than the near end or that adjacent to the boiler cellar. This is due to the fact that the coils are fed at the far end and the fault is more noticeable in long than in short houses. The most common and the simplest arrangement of piping for hot-water is in coils of parallel lines under the benches, these coils being vented at the high end, which is at the far end of the greenhouse. The coils may be either vented by air cocks, which should receive regular attention, or by automatic air headers which require no attention. The most even distribution of temperature is procured by dividing the coils into an equal number of flows and returns.

“It has been mentioned that large pipes and small pipes are used for hot-water heating. The large pipes referred to are $3\frac{1}{2}$ -inch cast iron pipes which are cast in lengths of 9 feet and are caulked together by the use of the rust joint. This joint is made by caulking into the head of the socket of the pipe or fitting several

strands of tarred rope for a foundation. On top of this foundation iron borings moistened with water are caulked. This joint when tightly and properly caulked is one of the best joints possible, for it is then of the same substance and same consistency as the pipe itself, and is, therefore, subject to the same degree of expansion and contraction.

"The great advantage of using large pipes has been explained, *i.e.* that they carry their heat better through the night than do smaller pipes. There is another and quite as important a quality, which is that cast-iron pipe will often last twice as long as wrought pipe. There are many systems still in use which were constructed of cast-iron pipe thirty-five or forty years ago.

"The small pipe referred to is 2-inch wrought-iron pipe, which is used now more extensively in commercial plants than in private systems. The reason for this is, doubtless, that wrought-iron pipe is cheaper per linear foot and cheaper per square foot of surface than cast-iron pipe, and also because the commercial grower is willing to give some attention to his heating system if necessary, through the night, if his plant is small; and if his plant is large, he keeps a night fireman, so the carrying power of the larger pipes is not expected and is not so necessary.

"The coils of 2-inch pipe are constructed in the same manner as those of $3\frac{1}{2}$ -inch pipe and are placed in the same way under the benches, only it is necessary to place more lines of 2-inch pipe than would be necessary of $3\frac{1}{2}$ -inch pipe; 1.68 linear foot of 2-inch pipe is equivalent to 1 linear foot of $3\frac{1}{2}$ -inch pipe in superficial surface, and contains a little more than one-half the quantity of water contained in one linear foot of $3\frac{1}{2}$ -inch pipe. Two-inch pipe fittings and automatic air headers are now made

with hubs so that 2-inch pipe may be caulked into the fittings with rust joints, and a variety of hubbed coil fittings may now be found on the market that are not to be duplicated in screw fittings. The use of such fittings is attended with a considerable saving of labor and expense for tools.

“The mains of a gravity hot-water system are generally run parallel to each other in cellar and trenches. The flow main and return main are of the same size of pipe. The expansion tank should be placed as high as possible above the radiation, and be connected to the return main near the boiler or to the boiler itself, as low as possible, by the expansion pipe. The capacity of the tank should be about one-twenty-fourth of the aggregate capacity of the coils, mains and boilers. The boiler should be located in a pit which it is always an advantage to have as deep as practicable. The lower the heater below the radiation, the more positive will be the circulation through the pipes.”

84. Closed tank or pressure system of hot-water, safety-valve control. — “With the closed tank system, which is very little used now, excepting that there is a growing use of the mercury seal, the coils of pipe are arranged in the same way, whether of large or small pipe, as in the open tank system. The mains are practically of the same size, and the boiler is the same, the expansion tank is provided with a weighted safety-valve at the vent or overflow. This valve opens when the water reaches a certain pressure. There is always some danger that the safety-valve will become corroded and so become inoperative, in which case an explosion is certain. The object of the safety-valve is to put the water under a pressure and so attain a higher temperature in the pipes, and

perhaps a little better circulation, and also to diminish the quantity of radiation necessary. This system is not recommended for greenhouse heating. The desired results are seldom attained in practice, and the element of danger is too great."

Mercury seal control. — "The mercury seal, or heat generator, as the manufacturers call it, is a device placed on the expansion pipe between the boiler and the tank in such a manner that the increased volume, or expanded water must force itself through a pot of mercury, the specific gravity of which is 13.6, which keeps all the water between the boiler and the seal at a pressure of about 13 pounds. This device is safer than a weighted valve, but the same purpose may be accomplished by increasing the elevation of the expansion tank, which is certainly simple, although it is not always possible. It might be added here that simplicity is undoubtedly a virtue in greenhouse heating. Every valve and every device of every kind should be as nearly fool proof as possible."

85. Forced circulation of hot-water. — "There are so many different combinations of forced circulation units that it would be impossible to explain them all. The simplest of these systems would be more correctly called accelerated hot-water circulation. The system is in every detail constructed like an open tank gravity system excepting that a propeller, driven by electricity, is inserted into one of the mains, and the propeller or circulator increases the velocity of the circulation. This device is practicable and of much merit.

"It will be recognized that it is a difficult matter in a large greenhouse range, heated by a gravity system of hot-water, to make every coil an efficient unit. There

are numerous coils of all lengths, sizes and shapes conforming to the peculiarities of the range of houses and to the bench arrangement in the houses. The expansion tank is not in the attic on the second, third or fourth floor, as in dwelling house work. It is often, in fact, within 4 feet above the level of the coils, so there is very little head, and the circulation due to gravity alone is in some coils sluggish, to say the least, in large ranges. To such systems a circulator or accelerator is a decided benefit.

" In other cases a small centrifugal pump is used. This pump may be driven by an oil engine, a gas engine, a steam engine or by electricity. In still other cases a large steam boiler or battery of boilers is used, and the water is heated in a large converter or feed water heater, the water being heated by live steam from the boilers, the circulation forced by a large, steam-driven centrifugal pump, rotary pump or double-acting piston pump, and perhaps a secondary or exhaust steam heater is used, through the coils of which exhaust steam is passed, so getting as fine an economy as possible.

" Pea-coal, buckwheat, rice-coal, screenings, or slack, the cheapest fuel procurable, is burned by means of a fan or forced draft. In still other cases the water is heated in a large tubular boiler. A smaller steam boiler furnishes the power for driving a small engine required for the operation of the fan and pumps, and the surplus live steam from the steam boiler may be used for auxiliary steam radiation for evaporating sulfur in the houses, for keeping gutters free from ice, or for heating manure water and very little heat need be wasted.

" The mains for such a system are small. They are smaller than are necessary for the steam main of a steam

system of the same size, which are in turn considerably smaller than those required for gravity hot-water systems. Forced circulation of hot-water is, without doubt, the ideal heating system for large ranges of greenhouses, whether for private or commercial use. By this system a mild heat, so much desired for plant culture, is obtained. The system has a range of heat almost as great as a steam plant. It is nearly as responsive and does not require such large pipe for mains or connections as either steam or hot-water. Neither does it require large pipe for radiating surfaces, because it does not depend on a large quantity of heated water to maintain the required temperatures."

86. Low pressure steam heating with gravity return. —
"The radiating surfaces in low pressure steam with gravity returns are placed in the same general positions as are hot-water radiating surfaces, that is, under benches and on side walls. There are as many or more ways of constructing and laying steam coils as there are of hot-water coils. It is only necessary, however, to avoid water pockets, or in other words, to secure a good, natural drainage, *i.e.* by gravity of the water of condensation. This is obtained by arranging the piping in proper size and pitch.

"There are two principal ways of arranging the coils; namely, under the benches and at the sides of the house. One way is by converging the coils so that the steam and return valves are at the same end of the house. The pipes begin at one end of the house, a considerable distance apart, and pitch so that at the far end of the house they approach each other very closely. The condensation is then carried with the flow of steam, the pipes pitching all the way. The other way is to carry the mains over-

head in the same way as previously described in hot-water overhead mains. This system is not as objectionable for steam as it is for hot-water for the reason that there is little loss of pressure in the length of the coils, and consequently very little change of temperature in the length.

"The steam mains may be run with the return mains in a trench, or the steam main may be overhead. It is only necessary to keep the steam main free from water."

87. Low pressure steam heating with steam return trap. — "In many cases it is not practicable, perhaps not possible, and maybe not desirable to excavate a pit of sufficient depth for the boiler, so that the water of condensation may be returned by gravity. In such cases, the water is returned to the boiler by means of a return steam trap. There are a number of different designs of return traps, but they all work on about the same principle. They are usually placed at a height of about three feet above the boiler, and connected to the boiler by two pipes, a steam pipe to the top of the boiler, and by a water feed pipe to the bottom of the boiler. They are also connected by a vertical pipe to a receiver, into which the returns drain. The operation of these return traps is, briefly, as follows: the condensation of steam in the vessel of the trap causes a partial vacuum to be formed, and as there is some pressure against the water in the receiver, the water is forced up into the vessel which is so fixed as to tilt when it has received its load. This tilting opens a valve, which turns the steam into the trap, thus putting the full boiler pressure of the steam upon the bucketful of water, and closing the check-valve in the pipe connected with the receiver, so that the whole charge of water in the return trap falls into the boiler by gravity."

88. High pressure steam at boilers with reduced pressure in greenhouses, and pumped returns. — “ High pressure steam is not adaptable for use in radiation in greenhouses, for the heat is far too intense. However, high pressure steam is often used with a reducing-valve, so the average temperature inside the greenhouses is considerably less than that in the mains or at the boiler. It is then found necessary to use a pump to return the water of condensation, and this pump may be operated by the high pressure steam. The pipe coils are distributed through the greenhouse in the same manner with this system as with other steam systems.”

CHAPTER VII

MANAGEMENT OF GREENHOUSES

THE management of greenhouses varies with the crops to be grown, but some rules apply to all ranges. Often success depends in a larger measure on the capabilities of the caretaker, than on the soil, the temperature or the moisture conditions in the houses.

89. Neatness. — A prime requisite for success in plant growing is that the houses be clean. Cleanliness adds, not alone to the general appearance of prosperity, which insures the confidence of the trade, but it has much to do with the healthfulness of the crops grown. Too few florists realize this. When dead foliage, papers and other waste material are allowed to remain under benches and along walks, they accumulate moisture, and the warm, moist condition fosters the growth of many disease germs. Sanitary conditions are as essential in greenhouses as they are in the home. Disease spores are abundant everywhere, and if the tissue which develops them is allowed to accumulate in the houses, the rapidity with which disease spreads is increased many-fold. The walks should be swept frequently, the waste which accumulates under the benches removed, and the interior painted or whitewashed, at least once a year.

90. Maintaining correct temperature. — Most species of plants have definite temperature requirements. If not carefully maintained, abnormal growth results. Growth

may be so rapid that soft, succulent tissue is formed, which is especially susceptible to disease; or a temperature unsuited to a species may produce a stunted growth. The best plant and flower producers are those who study their temperature conditions carefully and adapt them to meet the needs of their crops. Varieties of carnations have different temperature requirements and a variety may not meet the expectation of the grower. The soil and its moisture conditions may be ideal, but blooms are small, short-stemmed and lacking in vigor. It is quite possible that this particular variety needs a slightly increased temperature, and if furnished, ideal blooms may be produced. Fluctuating temperatures are extremely injurious to plant growth, and a careless man in charge of house temperatures may, in a short time, do much harm to the vigor of a crop.

91. Ventilating. — Plants need an abundance of fresh air, but changes in air contents of houses should not be pronounced. It requires excellent judgment on the part of the caretaker to admit sufficient fresh air to stimulate plant growth without chilling the plants; this is especially true in small houses on bright, cold days in winter. Night ventilation is also important, for although plant growth is not developing, due to the lack of sunlight, nevertheless the air in the greenhouses should not be heavily charged with moisture; and there should be as pure atmospheric conditions by night as by day. This often necessitates the application of a coil or two of steam, even in warm nights in summer, and an elevation of the ventilators so that surplus moisture in the houses may not accumulate on the foliage, thereby favoring the production of disease.

The caretaker should know his houses and the amount

of air each requires under ordinary and unusual outside weather conditions. In large houses, where the ventilators are too high for the operator to observe just how much air he is applying, a gauge of some description should indicate the number of inches the ventilators are raised.

The amount of air each species of plant requires, and often the amount required by each variety, should be known by the expert caretaker. Some species of orchids, for example, naturally grow only on lofty trees. Such demand a light, airy location in the houses. Other species grow near the ground, in moister atmosphere and often in diminished light. Certain other species of tropical plants demand moist, shaded locations, while others require full exposure to sunlight. An expert plant-grower knows plants thoroughly and their requirements in every respect. The man in charge of ventilating should be where he can reach his ventilating apparatus easily and at all hours of the day. Frequently on cloudy days in winter the sun bursts through the clouds and in a very few minutes the temperature in the houses may rise several degrees. Air must be applied so there will be a gradual increase in temperature, rather than a sudden change. Reverse conditions may occur by sudden cloudiness, and especially by strong, unexpected gusts of wind. Such variations in temperature bring about attacks of mildew which often take a long time to eradicate.

92. Firing. — On large ranges it is necessary to employ expert firemen for day service as well as for night service. Such men thoroughly understand their business, and are able to get the maximum amount of heat from the minimum amount of coal. On smaller ranges, the fireman often has other duties to perform, but the care of his fires should always be his first consideration. Too rapid

combustion wastes coal, and too slow combustion may chill the plants. A fireman should be given a boiler of sufficient capacity to heat the houses to the required temperature and the houses should also be well piped. The fireman's duty is to keep the pipes sufficiently warm at all hours of the day and night. The boilers should be kept clean or there will be a pronounced loss of heat. Ashes should never be allowed to accumulate underneath the boilers.

93. Watering.—Watering in greenhouses is an art, the skillful operation of which few American gardeners master. This duty requires much good judgment. Probably no one factor is more injurious to plants, and at the same time more liable to occur, than overwatering. On the other hand, neglect and drying out are also injurious. No hard and fast rules can be given for the application of water. The grower must learn from careful observation when it should be applied and when withheld. Plants in beds and benches are more liable to be overwatered than are those in pots. This is especially true when it is necessary to syringe frequently to keep insect pests in check. The average workman fails to distinguish between syringing and watering. In the first instance, it is possible by means of a fine spray to cover the foliage without wetting the soil to any extent, while in watering the soil is moistened without wetting the foliage. The novice finds this difficult. Often the surface soil may be dry, while the soil beneath is sufficiently moist for plant growth. This is especially true after the surface soil has been recently stirred, and extra applications of water would be injurious. On the other hand, if the beds have been lightly watered several times, it is quite possible that water has not penetrated deeply enough into the soil to reach the basal root system. It is, therefore, better to wet the bench so

thoroughly that the moisture cannot have failed to penetrate to the lower strata of soil. As soon as the surface has dried sufficiently so that it is not muddy, the surface soil should be stirred. This keeps the bed uniformly moist, and in the best condition to nourish the plants. In watering beds or benches, there are spots where the drainage often varies. A careful caretaker will watch out for such places, and will apply less water. A man should never take a hose and indiscriminately dash water over the plants and benches.

Watering potted-plants also requires careful study. In a bench of plants, there are always a few which require daily watering. Others may need water only once in two or three days. The benches should be gone over carefully every day, and water given to only those plants in need of it. Surplus water in houses should be avoided. The moisture has a tendency to cause decay in benches, beds and the underpinning of the greenhouses. On bright days, however, especially in spring, summer and fall, the walks should be wet frequently and thoroughly. This maintains a moist atmosphere which is favorable to the growth of most species, and prevents in a measure the red-spider pest. Moisture on the walks is particularly essential for a healthy development of palms, ferns and other foliage plants. As a rule, it is best to water plants in the early morning in winter, and in the late afternoon in summer. Plants should be thoroughly syringed on bright, sunny days.

94. Shading the houses. — Some species of plants are injured by too strong sunlight. The caretaker must use careful judgment to determine when shade should be applied and when removed. As a rule, the propagating house should be shaded, unless it can be so arranged that

it gets only northern light or sunlight for a part of the day. Too strong shade induces a soft, sappy growth which is more susceptible to disease. When plants are first transplanted, the glass should receive a thin coating of shade until the root system becomes established. This is especially true when large plants, like carnations, are transplanted from the field, and a decided check to the plant follows. After they become established they need full sunlight, so the shade should be of a character which may be removed easily. Palm and fern houses usually have permanent shade, for this insures a dark, rich color to the foliage. Ground glass or "frosted" glass is most generally used in houses for foliage plants. A durable shade may be made of gasoline and white lead mixed to a consistency of thin cream, with a very little boiled oil adfled. This is removed with difficulty from the glass, and should be applied only for a permanent shade. Temporary shades are made of whiting and naphtha, of proportions varying to secure the required density, and are easily removed. A little salt may be added to give the shade a more permanent character.

Shade may be applied with a spray pump, provided it is carefully and evenly done. A careless application is extremely unsightly. On private conservatories and where a more attractive shade is desired, the glass is usually coated with a brush.

During cloudy days in midwinter, most flowering plants require full sunlight and the clearest glass possible.

95. Propagating. — The caretaker of a house should have a succession of plants. As a rule, old stock plants become unsightly, and dwarf, stocky ones are always more attractive. The flower- and plant-grower should know when to propagate plants of different species so that they

may be in flower at a given date, as for instance, great festival holidays, like Christmas and Easter. Many of the best growers have definite dates for making cuttings or sowing seeds of various species, and are extremely particular that nothing prevents the work from being done. When carnation, chrysanthemum, rose or violet cuttings are to be taken, time must be allowed for the growth of healthy, vigorous plants before any flowers are produced. A good propagator will know just what wood to select for his cutting, and will have learned from experience just how long to make the cutting, and the time it should be left in the propagating bench. A plant propagator should work rapidly, for, as in all branches of greenhouse work, time is valuable. The margin of profit between the cost of growing a plant and its sale price is comparatively small, hence many cuttings should be made in a day. This cannot be done with dull or carelessly prepared tools. Everything should be in readiness before the work is begun, or the results are unsatisfactory. To have sharp knives is very important. Many plant propagators fail in seed germination. This may be due to carelessness in sowing, or in watering. Small seeds frequently fail in germination because of lack of care. Special cases should be provided for very small seeds difficult to germinate, and the propagator should give them his most careful attention. Many plant propagators are considered lucky in their success in germination, when it is very probable that their success is due to the painstaking care they give their seeds and seedlings. The propagating houses, particularly, should receive careful attention. Cleanliness is especially essential in the sand of the cutting bench. Any decaying vegetable matter, such as leaves and sections of stems or flowers, will have a tendency to cause the "damping-off"

fungus which is so destructive to soft-wooded cuttings and seedlings.

96. Potting. — Every up-to-date establishment where potted plants are grown will always have an adequate supply of pots. It is not economy to limit this supply. In the earlier days of commercial growing of potted plants, it was not considered essential that pots be clean. An accumulation of dried soil and dead root tissue inside of pots is injurious to the healthy root growth of other plants placed in them. Also, an accumulation of algæ and other foreign matter on the outside of the pots prevents aëration of the soil, and consequently inferior root development results. It is now considered economy to clean all pots at least once a year. This may be done easily, by soaking them for a few hours in a half barrel of water. If live steam can be turned into the tub until the temperature of the water is raised several degrees, the dirt and algæ may be removed with ease. If clean pots are soaked for a short time in a solution of ammoniacal carbonate of copper, all spores will be destroyed, and a new growth of algæ will not appear for a considerable time. When new pots are used they should be soaked in water before using. This prevents the dry pot from drawing moisture from the soil of the freshly potted plant, increasing its tendency to wilt.

In potting freshly rooted cuttings from the propagating bench, or in re-potting older plants, everything should be conveniently arranged to facilitate rapid work. Many men who are potting plants lose valuable time because of a lack of system. First, the soil should be carefully prepared, and for most plants it should be sifted. The space between the root system and the pot is small, and the soil should be fine enough to fill all spaces. It should

be of just the right degree of moisture, not dry enough to be powdery, but should absorb water slowly after the potting is done. On the other hand, it should not be wet enough to bake or to become too compact after the plant is re-potted. It is not advisable to prepare large quantities of soil much before the potting is to be done.

The soil should be placed on a smooth, clean bench, of the proper height to facilitate easy working, and directly in front of the workman. A flat filled with plants to be re-potted, or a damp paper on which are laid the rooted cuttings, is placed on top, and a little to the back of the pile of soil. Several rows of clean, moist pots are placed at the workman's left, and a flat to receive the potted plants is placed at his right. The workman takes a pot with his right hand and places it on the clean board in front of him. He then takes a cutting with his left hand, and at the same time fills his right hand with soil. He places a little of the soil in the bottom of the pot, then places the rooted cutting in position with his left hand, and fills the soil around it from his right hand. When the pot is filled level full or a little over, the workman grasps the pot in both hands, with the thumbs over the surface of the soil, and then gives the pot a quick rap on the bench, at the same time pressing downward with the thumbs. This firms the soil sufficiently in the pot, and gives space on top for water. The operator then places the potted plant in the waiting flat with his right hand, at the same time reaching for another pot with his left. By this method many plants may be potted in a day.

When potted plants are grown on a large scale, it is often necessary to pot several thousand in a day. This

is easily possible when the work is rightly arranged. In re-potting plants, care should be taken not to get them into pots which are too large. They are troublesome to move, they occupy valuable space in greenhouses, and often plant growth and flower production are as satisfactory when the root area is limited. However, there should be sufficient soil to nourish and facilitate a healthy growth. Flowering plants should not be re-potted just as they are coming into bloom. When necessary, this should be done several weeks previous to the time of blooming, so that they will be somewhat pot-bound. This has a tendency to stimulate flower production, and to retard vegetative development. This condition should not be carried far enough to give the plants a starved appearance, but as a rule, if flowering plants are allowed to become somewhat pot-bound and are then fed with liquid manures, the results are much better.

97. Feeding. — A careful grower will feed his plants just as a mother carefully feeds her child. In general, the same rules apply to feeding young plants as apply in feeding infants. When cuttings freshly rooted are taken from the sand, they should be given a soil only a little richer than the sand. Ordinary garden loam in which there is little active plant food is best suited for them. Soils highly fertilized with nitrogenous plant foods are sure to give cuttings severe attacks of indigestion which should cause the plant grower many hours of lost sleep. Plants, unfortunately, are not capable of resenting injudicious feeding as forcibly as are children. In a second potting, increased fertility may be given the soil, until gradually plants are able to withstand heavy applications of highly nitrogenous plant foods. It is the duty of growers to discern when plants are getting all the food they have

power to assimilate, or when they are ready for an increased supply.

As has been said, it is often necessary to give pot-bound plants liquid manures or other fertilizers. Liquid manures are preferable, as they are safer to apply in liquid form than are the so-called commercial or chemical fertilizers. Liquid stable manure is suited for most plants and rarely injures them after they have established a strong root system. A bushel measure of solid manure dissolved in one hundred gallons of water may be used for the majority of plants. If plants are growing vigorously or are strong feeders, like chrysanthemums, the bushel of manure may be dissolved in fifty gallons of water with good results. If soot is added in the proportion of one part soot to ten parts manure, the color of the foliage of most plants will be darkened and made vigorous. This mixture should be stirred frequently and allowed to stand several days before using. Nitrate of soda applied in liquid form, is often beneficial in stimulating plants into rapid growth. This should be applied carefully or the root system will be injured. A level teaspoonful of nitrate of soda to eight quarts of water will be sufficiently strong for most plants. It should be thoroughly dissolved and stirred before applying to the plants.

98. Cultivation. — Good plant growers realize the importance of careful attention to soil cultivation. The surface soil should not be allowed to bake, and it should be stirred lightly as soon as it has partly dried out after each heavy watering. This not only serves to conserve moisture, but assists in aerating the soil and keeping it "sweet," as florists express it. Weeds should never be allowed to grow, and if kept in check early in the season, they rarely cause any trouble. All plants should be carefully sup-

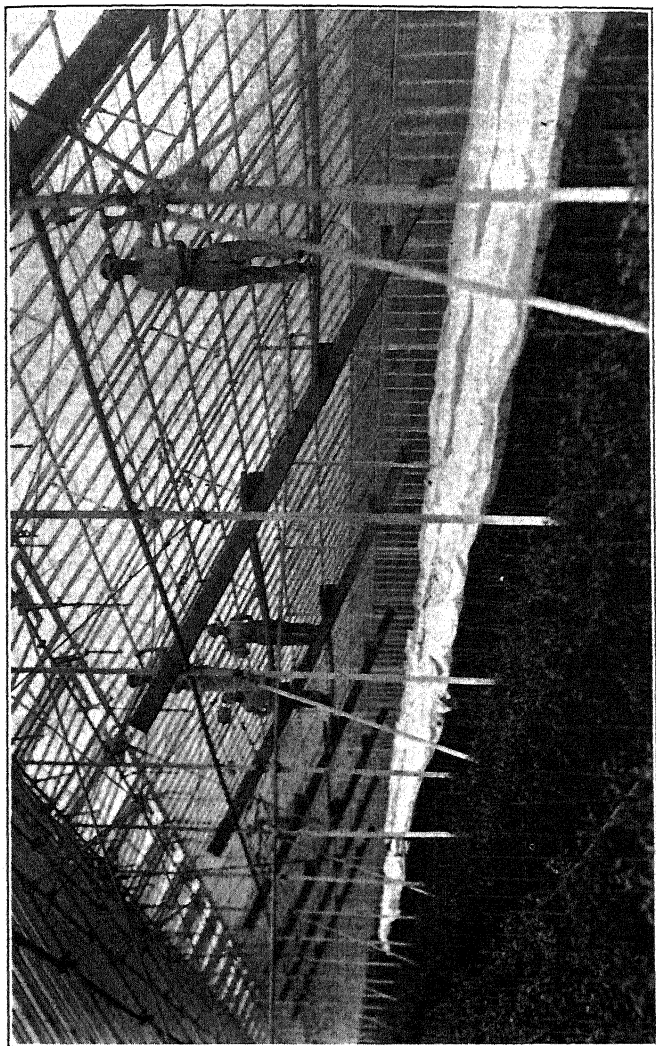


FIG. 17. — Repainting the greenhouses.

ported, otherwise few will produce satisfactory flowers. The earlier it is supported, the better the grade of blooms produced.

99. Fumigation. — The truth of the old adage that "a stitch in time saves nine," was never truer than in the treatment of plants for insect attacks. If insects once get a foothold in houses, they are eradicated with difficulty. A first class grower rarely has insects in his houses. Benches and beds are thoroughly overhauled each season, and a coat of whitewash or paint is applied. As soon as plants are well established in the houses, a light fumigation with some tobacco preparation, or with cyanide of potassium is given, and is repeated every week or two. If this treatment is adhered to, insects cause little trouble.

100. Treatment for diseases. — In the human family, careful attention to sanitary surroundings has much to do with the health of individuals. The same statement holds true in the vegetable kingdom. When plants are in proper soil, nourished by proper food in the right amounts and surrounded by pure air of correct temperatures, they cannot fail to be healthy. It is true that in some cases, disease is inherited, but correct environmental conditions help greatly in keeping this in check. The caretaker should study his plants and their requirements, and then aim to make their surroundings as nearly ideal as possible.

101. General repairs on the greenhouse. — Every man in charge of greenhouse work should have a knowledge of setting glass and of doing general repair work, both in wood and in the piping of the heating system. The range should be repainted frequently, for if the paint wears off from the putty, water may get under the glass and decay of the sashbars result. Greenhouses should be repainted as often as once in two years (Fig. 17).

This may be best done during the summer. Less moisture condenses in the houses then and usually the summer is a dull season when many workmen may be available for repainting. Special men may be employed for this work, but emergencies will arise when it may be necessary to re-glaze a section immediately, or a break in the heating system may demand immediate repair. The efficient man is then the ready man.

102. Care of the hotbeds and coldframes. — Every progressive gardener has an up-to-date equipment of hotbeds and coldframes to supplement his greenhouse space. They are exceedingly valuable for starting early plants of various kinds, and for hardening them sufficiently so that they gradually become accustomed to outdoor temperatures in the spring. The time to start hotbeds varies in different localities, and with different years; usually they may be started by the first of March.

Manure for the heating of hotbeds should be prepared earlier. The amount required will be approximately two cubic yards of manure for every sash of standard size. A heap of fresh stable manure may be mixed with half its bulk of dry leaves. If leaves are not available, straw may be used. The using of leaves or straw renders fermentation less violent, and the heat in the bed will become more permanent. When the pile has fermented for two or three days, it should be forked over to prevent any burning of the material. During the fermentation, the temperature rises, and the heat produced would be injurious to growing plants. After forking the manure over a second time, fermentation will again take place, but in a day or two the temperature will drop sufficiently to be safely used. The sub-frame should be filled to within sixteen or eighteen inches of the top on the south side. The

manure should be packed solidly, special care being taken to have the manure along the sides and in the corners packed as firmly as in the center.

The sashes are then placed on the frames, and the manure will again ferment, emitting strong fumes of ammonia. The temperature of the fermenting manure should be carefully taken with a soil thermometer, and when it has cooled to 90°, the bed is covered with a top-dressing of carefully prepared soil. This top-dressing should be from six to ten inches deep, depending upon the crop to be grown.

After sowing the seeds or transplanting the plants in this soil, the sashes are again placed on the frames, and stable manure or soil is banked against the outside. This is to assist in retaining the heat and in excluding the cold. It is necessary to give careful attention to the watering and ventilating of hotbeds. Too much water renders the soil cold, and the seedlings are easily chilled; if insufficient air is admitted, the plants are spindling and weak, and the fumes from the fermenting manure would kill them. If too much cold air is admitted, the growth is seriously checked. In ventilating, it is customary to use a small block of wood to prop up the sash. Hotbeds and frames should be protected with mats and shutters during the night. The careful gardener will apply the cover early enough in the afternoon, so that the frames may become warmed somewhat before evening. Success with frames and hotbeds depends in a large measure on the attention given them.

103. System and business principles. — A business man who lacks system seldom is a success. The range foreman who does not have his work well organized is inefficient. The best workmen are those who have a system.

All down the line, from the owner of the establishment or the president of the corporation to the errand boy, there should be a well-developed system of work. Needless energies are not then exerted, and every activity tends towards success. Business principles must have a firm foundation on business integrity, and every workman on the place should have as keen an appreciation and sense of honesty as the owner or the foreman of the range.

CHAPTER VIII

PLANT STRUCTURE AND ITS RELATION TO HEALTHY PLANT GROWTH

WITHIN recent years much stress has been laid on the fact that, in a large measure, a plant's environment has much to do with its vigor of growth and consequent healthfulness. In earlier years, disease in plant tissue was considered something to be combated rather than prevented.

Because of the intimate relation which exists between the physiological development of the plant and its health, every plant grower should have a knowledge of plant structure and those vital processes which contribute to its vigor. These the botanist classes as plant morphology and plant physiology. To get a clearer understanding of the relation of plant structure and growth to healthfulness in plant tissue, they are discussed under the following topics :

PLANT STRUCTURE

When man was dependent on the power of the naked eye to disclose plant structure, much mystery regarding life prevailed. As yet, the question "What is life?" remains unanswered, but scientific men have disclosed many facts which have brought us nearer the solution of the problem. The development of the compound microscope resulted in many wonderful discoveries. Among them is the fact that plant structure is a wonderful com-

bination of minute chambers which are called cells. It became known that there are many low forms of plant life which consist of but a single cell. A study of these revealed the fact that within this individual cell lay the vital element which is known as life.

104. Cell characters. — In 1846 Mohl of Tübingen, in his study of the cell, gave to the contents of this cell the name of protoplasm. It was discovered that this protoplasm would exist for a time under certain conditions without any special envelope or protective covering. As a rule, however, it secretes at once a firm outer coat and so builds for itself a dwelling house. This is now called the cell wall. The cell wall with the protoplasm which it contains is known as the unit of plant structure, and every plant culturist in dealing with the whole plant should recognize the importance of this individual part.

The microscope reveals the fact that this protoplasm is not simply a mass of semi-fluid, more or less transparent, but it has definite directions of circulation, and within it are bodies of definite shape and size. One distinct body exists in all cells, and to this is given the name of the nucleus. Other more or less transparent bodies are discerned, and these are called plastids, or protoplasts. When they are perfectly white, they are called leucoplasts, when green, they are termed chloroplasts, and when red, chromoplasts. The predominance of these different colored atoms gives characteristic colors to the cells. The importance of them in plant growth will be noticed later.

105. Cell arrangement. — Low forms of plants which consist of but a single cell are, for the most part, nearly spherical. Higher forms of plant life begin their existence as a single cell, but have the power of cell division,

so that cross walls form and the original cell becomes divided into many cells. This process of division brings more or less pressure on the cell walls, causing them to assume various forms. In the higher types of plant life, these differently formed cells function in various capacities. Some serve to absorb food contents, and some to conduct food to other cells. These, in turn, have the power of changing crude food substances, as they are taken into the plant, into material which becomes a part of the protoplasm, therefore building up plant tissue. Individual cells often become elongated, and are shaped like rigid or flexible tubes.

As a plant matures the cell-contents change, and the protoplasm passes out from the older cells. The cell walls, however, remain and form the bulk of the individual. These cells are for the most part in the center of the plants; for example, the heart-wood of a tree. The vital, active cells are mostly near the outside where they are in direct communication with the oxygen of the air. Most plants have a more or less thickly developed outer covering, which is generally termed the bark, and from this bark dead cells are constantly falling off.

106. Cell names and their location. — The following are among the most common special cells with which the plant grower should be familiar :

Cells of the root and stem.

- (a) *Root-hairs.* — Root-hairs are more or less elongated, epidermal cells which are found on or near the tips of all living roots. They are mostly microscopic, but may be seen with the naked eye on roots of large seedlings germinated in sawdust (corn, bean).

- (b) *The root-cap.* — The root-cap is composed of cells beginning at what is known as the growing point, and gradually increasing in size until at the very tip of the root they become functionless and fall off.
 - (c) *Cells of the vascular bundles.* — Beginning at the root-tips and passing lengthwise throughout the roots and through the stem to the leaves, are the vascular bundles of cells of the plant. They are more or less elongated tubes. The ends of these cells often become perforated, and these special tubes are then spoken of as sieve tubes.
 - (d) *Storage cells.* — The cells surrounding the vascular bundles simply serve as storage reservoirs to hold food which is not needed for the immediate use of the plant.
 - (e) *Cambium-layer cells.* — Cambium-layer cells are active cells which later form a part of the vascular bundles. They are just beneath the bark.
 - (f) *Bark cells.* — On the outside of the stem and root are cells having more or less thickened cell walls. These are the bark cells.
 - (g) *Heart-wood cells.* — Heart-wood cells are cells which have become practically inactive. They are mostly in the interior of the plant.
- Leaf cells.* — Leaf cells are variously modified to suit the needs of different plants. They are:
- (a) *Epidermal cells.* — Coating the outside of leaves are transparent cells, variously modified according to the leaf. They are often elongated into hair-like bodies.
 - (b) *Guard cells.* — Among the epidermal cells, both on the upper and the lower sides of the leaves, but

more abundant on the lower side, are the guard cells. They surround various openings in the leaf, which are called stomata.

- (c) *Palisade cells.* — Palisade cells are narrow, upright cells, placed closely together near the upper surface of the leaf. They contain many chloroplasts.
- (d) *Spongy cells or parenchyma.* — Below the palisade cells are located large, loose cells with many air spaces between them. These air spaces usually connect directly with the stomata.

Other cells of the leaf are vascular bundles or veins, and storage cells, similar to those which are found in roots.

GROWTH AND HOW IT IS ACCOMPLISHED

As has been stated, life, in even the higher plants, begins with a single cell. This cell is the dwelling place for the vital fluid which is known as protoplasm, and contains the most vital of all parts, the cell nucleus. Protoplasm possesses a strong affinity for water, and by a process which botanists call osmosis, it draws water into itself until the cell wall is fully distended. Osmosis, then, is the attraction which a denser liquid has for one less dense. As long as the soil water is not too highly charged with food substances, the protoplasm draws in through the cell wall, not only soil water, but also food substances which the water holds in solution. This is passed on to other cells by osmotic action and by the tendency of liquids to diffuse until all parts are of a uniform character. Thus enriched, the protoplasm begins to form a new cell wall which always extends through the nucleus, dividing it so that a portion goes into each new cell. Thus cell division goes on indefinitely.

With this division, the individual increases in size, and this increase is termed growth. The vigor and healthfulness of a plant body is, therefore, dependent on the proper action of each individual cell. Because of this fact, it is necessary that the successful plant grower have an intimate knowledge of the function of each cell and the conditions which favor its healthy action.

107. Function of various cells.

- (a) *Root-hairs.* — Root-hairs serve to take the soil water and the food substances which are dissolved in it, into the protoplasm of the epidermal cells of the root. This is done by the process of osmosis, previously described. All plant foods from the soil must, therefore, be in solution. As root-hairs are located but a short distance from the root-tip, plants feed from the soil only from this part of the roots. No matter how long a root may be, the feeding area is limited to the immediate surface just back of the root-tip.
- (b) *The root-cap.* — The root-cap cells vary much in size. The inner cells, which are near what is known as the central cylinder, are small, but they gradually increase in size until those on the outside are quite large. The expansion of cell contents by growth pushes the root through the soil, frequently with sufficient force to cause the roots to penetrate extremely hard substances. The growth of the root in length takes place only at the immediate tip. The outer cells of the root cap, as they increase in size, become functionless and drop off.
- (c) *Cells of the vascular bundles.* — Elongated cells begin near the tip of the root and pass length-

wise through the root to the stem and to the leaves. These are vascular bundles. They serve as direct passages by which crude food substances pass from the root-hairs and the epidermal cells of the root to the cells of the leaf. Here, in the presence of light and air, the foods are changed into such forms as the protoplasm of the plant can use. The vascular bundles then conduct the prepared food back from the leaf to the active, growing cells of the root-cap and to other vital parts. The cells which conduct the crude sap to the leaves are near the center of the stem, while those which return the prepared foods are near the bark.

- (d) *Storage cells.* — If more food is prepared than the growing cells demand, the surplus food passes into cells in the immediate vicinity of growing parts and is there stored until it is needed. These storage cells are located near the cambium cells of the root and trunk.
- (e) *Cambium-layer cells.* — Cambium-layer cells are located just beneath the bark. Here active growth in thickness of the root and stem takes place. The cambium layer runs through the center of the vascular bundles, and is, therefore, near the food supply. The cells increase rapidly in size, and with it, rapid cell division takes place, and growth results. Growth in thickness of the stem, therefore, only occurs directly beneath the bark. Any injury to the bark of a plant interferes with healthful growth.
- (f) *Bark cells.* — Bark cells are on the outside of the growing tissue of the vascular bundles. They

serve as protective coverings for the delicate parts beneath. As growth in thickness takes place, the older cells become functionless and fall away. This is especially true of the bark of trees.

- (g) *Heart-wood cells.* — Heart-wood cells are those near the center of the stem, and have become functionless so far as food conduction and storage are concerned. Their purpose now is to strengthen the stem and thus support the foliage, so that all parts may be brought into full sunlight and better atmospheric conditions.
- (h) *Leaf cells.* — In leaf cells, extremely active processes of plant growth take place. Because of their activity and the need of fresh and thin tissue in which to manufacture plant food, the duration of the life of leaves is short. Upon the healthfulness and vigor of the leaves of the plants, depends in a large measure the success or failure of the plant grower.
- (i) *Epidermal cells.* — Epidermal cells are transparent, mostly brick-shaped cells on the upper and the lower surface of the leaves. The outer row usually has thicker cell walls, which serve for protection. It may also be variously elongated into hair-like processes which serve the same purpose. These epidermal cells are transparent so that the sunlight may penetrate easily to the palisade cells and spongy parenchyma beneath.
- (j) *Guard cells.* — In the epidermal cells are variously modified cells filled with protoplasm which is very readily acted upon by sunlight and atmospheric conditions. Under certain circumstances

these change their position, due to the movement of the protoplasm within them, and openings appear in the epidermis. These admit air, which is so necessary for healthy plant growth, to the interior of the leaf. Under other conditions, this protoplasm again changes its position and the stomata close. These stomata are intimately connected with air spaces between the spongy cells on the lower side of the leaf.

- (k) *Palisade cells*. — In the palisade cells, active food manufacture takes place. The protoplasm of these cells contains many chloroplasts. To this protoplasm with its green plastids, crude food materials are brought from the root-hairs through the various cells. The passage of the liquids is due to osmosis or to root-pressure due to cell growth in roots, and to other factors. These food materials are combined with the air which has entered the leaf through the stomata and which is more or less charged with carbon dioxide. By the action of sunlight, these plastids change the crude food substances into sugars, starches and other compounds which stimulate protoplasm into growth. They are transferred from the leaf to the tips of the branches, to the roots and to the cambium layer just beneath the bark, where active growth is in process. If it be at the approach of a dormant period of plant growth, the manufactured plant food changes its chemical character and goes into storage cells, there to remain until the next period of active growth.

The number of rows of palisade cells varies,

depending upon the requirements of a particular species of plant for food-manufacturing areas. The number of green plastids also varies in different species, due to the amount of food required by that particular species. This explains why leaves are of different shades of green.

(1) *Spongy cells or spongy parenchyma.* — Spongy cells or spongy parenchyma are below the palisade cells. They serve to collect gases and liquids and to hold them until the palisade cells use them in the manufacture of food. They also contain some chloroplasts and, therefore, serve to some extent in changing crude food substances into usable forms. In thick leaves, these cells are useful for storage of reserve plant food.

Running through the leaf tissue are numerous vascular bundles which are similar in structure and function to the vascular system of the stem and root. These serve to transport the liquids of the plant. They are called veins.

THE RELATION OF A PLANT'S ENVIRONMENT TO NORMAL CELL FUNCTIONS

A plant's environment, as regards soil, moisture and atmospheric conditions, has an intimate relation to the ability of the plant cells to perform their normal functions.

108. Number and function of root-hairs. — As has been stated, root-hairs develop in large numbers just back of the root-cap, which is the section of growth and consequent elongation of the root. As the tip of the root grows,

the older root-hairs die and new ones are formed. The number of root-hairs is important for they increase the feeding area, just as an abundance of leaf surface increases the area above the soil. It is essential that soil conditions be ideal for the development of large numbers of healthy root-hairs. As these are produced in a restricted area near the tip of the root, older parts of the root system become functionless, so far as food absorption is concerned. Long root systems serve simply to hold the plant in position.

In addition to absorbing soil water, which holds in solution many elements of plant food, root-hairs also excrete carbonic acid. This renders soluble certain minerals in the soil and thus makes them available for food for the plant.

It is a well-known fact that plants with many fibrous roots are more vigorous and rapid growing than plants with a few long roots. A plant with many root tips has a feeding capacity several times larger than has one with but few long roots. Then again, in plants with a few long roots, it takes more time for food substances to reach the leaves, there to be manufactured into food, and to return again to growing areas in the roots. All cultural treatment should aim to encourage root branching and to have this occur as near the base of the stem as possible. In greenhouse treatment of plants, this is done by transplanting seedlings when young; by repotting plants from time to time; by increasing plant food and moisture contents of the soil, and by giving proper soil conditions so that it is well aerated.

When a seedling is lifted for transplanting, the primary and many of the secondary roots are broken off. Then occurs, as in an injured stem, a rapid accumulation of food

material around the injured parts. This causes rapidity of growth. Buds are formed and consequently many young rootlets develop. Thus the feeding area of the plantlet is increased many fold. As this occurs near the base of the stem, the feeding root area is brought nearer the leaf area, the stem becomes stocky and the foliage dark green and healthful. Repotting plants which are pot-bound accomplishes the same purpose. Therefore, cuttings are placed in small pots which are frequently replaced by larger ones as the root system develops. If the soil is generously supplied with plant food and moisture, the roots will not be obliged to travel long distances in search of them. Consequently the roots will be shorter, while growth in diameter will increase proportionally.

Roots are dependent on the oxygen of the air for the healthy action of the root-hairs, therefore, it is essential that the soil be well aerated. There should be the proper relations between the soil-moisture contents and the air spaces of the soil. Water-soaked soil becomes sour and unsuited for alert growth.

109. Correct moisture contents of the soil.—The amount of water required by actively growing plants is considerable. The water is almost wholly absorbed by root-hairs, as leaves have no power to take in water. Healthful growth demands that at all times there be sufficient moisture in the soil, so that the plant may get sufficient food material in solution to nourish it. Growth by cell division can take place only when the cell walls are first distended with water. The strong affinity for water which protoplasm possesses is largely responsible for the expansion of plant tissue, such as the unfolding of leaf and flower buds. The elastic cell walls of growing tissue are distended until they are like minute, inflated bladders.

This tension holds the plant erect and when the moisture in the soil is reduced so that there is not an equilibrium between that taken in by the roots and the water which is passing off through the tissue of the leaf, the plant wilts.

Growth is, therefore, dependent on proper amounts of soil water. This varies in different species. Some plants are moisture-loving, while to others large amounts of soil water are detrimental. The plant-grower should study the peculiar needs of each particular species.

110. The proper amount of plant food. — The subject of manures and fertilizers is considered in another chapter. Only the principles which affect the absorption and assimilation of food will here be considered.

All food substances are taken into the plant in solution through the roots, or in a gaseous form through the leaf and other green parts of the plant. Those cultural conditions which favor the absorption of liquids and gases should be given plants, also the foods which are best suited for the individual species, and the correct amount. The diet problem in the human race and in animals has received careful study for many years. Plant-growers have only recently commenced to realize that the diet of plants should also receive consideration.

To understand properly the principles affecting the application of food, one should keep in mind that plants take their liquid food through the root-hairs, due to the fact that the denser liquid of the protoplasm has a strong absorptive power for the less dense soil water. If soil water is too highly charged with fertilizing elements, it becomes more dense in character and the protoplasm of the cell contents is drawn out, the root-hairs collapse and the root dies. This is what occurs in saline soils and renders them unfit for most plant growth. Fertilizers applied

in large amounts are often detrimental to plants. Light applications given frequently are better for healthy plant growth. When plants are given more food than they can readily assimilate, a diminished growth results and if they live, the plants are susceptible to disease.

Often when plants are highly fed, certain elements are not absorbed by the root-hairs. They remain in the soil, increasing the density of the soil water, and thus prevent a healthy growth. This quite frequently occurs in rose soils where the plants are heavily fed with nitrogenous fertilizers. It is especially essential that the rose beds or benches have excellent drainage so that this excess of salts, which becomes detrimental to healthy growth, be washed out of the soil by the application of clear water.

Definite rules for the application of fertilizers are difficult to give because plants of different species have such varying requirements.

111. Atmospheric conditions. — The second source of plant food is from the air and is a most important one. The living protoplasts within the protoplasm make use of the carbon dioxide with which the air is heavily charged. This gas penetrates a cell wall saturated with water, more readily than do other constituent gases of the atmosphere. In the wall, it is converted into carbonic acid, due to its contact with water, and it then passes into the cell sap of the protoplasts. The quantity of carbonic acid absorbed is determined by the requirements of the cells of particular species. The requirements vary with the time of day. During daylight, all green plants require a quantity of carbon dioxide. Fresh supplies are constantly needed, hence the importance of good ventilation in greenhouses. The air should at all times be free from dust or other substances which tend to clog the stomata of

the leaves. Temperature and moisture conditions should also be ideal, to facilitate the action of these stomata, which are to allow gases to penetrate the leaf readily.

Kerner¹ describes the action of nutrient gases in plants as follows :

"As soon as carbonic acid reaches the cell sap, it is decomposed and reduced by the action of the sunlight, and from it are formed compounds known as carbo-hydrates. The oxygen thus set free is, however, removed from the cell precincts and expelled into the surrounding air or water. In this way, the gas, when barely absorbed, is withdrawn as such, from the cell sap, the carbon alone being retained and the oxygen eliminated and a renewed attraction of carbon-dioxide from the surrounding medium ensues. The fresh supply again is immediately worked up in the green chlorophyll-bodies so that there is a constant influx of carbon dioxide and, therefore, indirectly of carbonic acid from the environment into the interior green cells to the part where its consumption takes place. Were it possible to see the molecules of carbon-dioxide in the air, we should observe how much faster they are impelled towards the leaves and other green parts of plants, where the intense craving for carbon is localized, than are the other constituent particles of the air. This impulsion and influx lasts so long as the green cells are under the influence of daylight. The first thing in the morning when the first ray of sunshine falls upon a plant, the protoplasts begin work in their little laboratories, decomposing carbonic acid and producing from it, sugar, starch and other similar organic compounds. And it is not till the sun sets that this work is suspended and the influx of carbon-dioxide stopped till the following morning."

¹ "The Natural History of Plants," Kerner and Oliver.

Healthy plant growth cannot go on without correct moisture conditions in the atmosphere surrounding plants. We have seen that large amounts of water are absorbed by the roots. This water serves as a medium to convey food substances about the plant, and while it furnishes hydrogen and oxygen for plant food, the large amounts taken in are not needed. Surplus water, therefore, passes off from the leaf through transpiration. Upon the proper transpiration of moisture from the leaf surface of plants, depends in a large measure the healthy development of the species. This, too, calls for careful attention to ventilation in greenhouses. For example, transpiration is more rapid in light than in darkness, because the stomata are open in the light and they facilitate the escape of water from the leaf. Transpiration is more rapid under dry atmospheric conditions than under moist. It is, therefore, necessary for the florist to moisten the walks frequently and to fill the air with moisture several times during the day, especially in bright, sunny weather. This prevents too great a transpiration of water, which would injure the plant. Some plants cannot thrive in a dry atmosphere. Rapid transpiration kills them. Nature prepares such plants for a dry atmosphere by giving them a thickened epidermis or by diminishing the number of stomata, so that transpiration is checked. Plants which make a rapid growth need to transpire more than slow growing plants. Houses for palms, ferns and other tropical plants should have a moister atmosphere than houses filled with plants from temperate sections, as roses and carnations, which are being forced into rapid development.

112. Light conditions.—In considering the correct atmospheric conditions for healthy plant development, reference was made to Kerner's work regarding nutrient

gases. We noticed there the importance of the part played by the sun's rays in the preparation of plant food.

The proper amount of light which plants of different species should receive has never been demonstrated satisfactorily. We know in a general way that the growth of species, classed as "shade enduring," is often retarded by being placed in strong sunlight. Again, the growth of plants accustomed to strong sunlight becomes unhealthy and weak when placed in the shade. Most flower crops, however, demand maximum sunlight. Many foliage plants, as palms and ferns, are injured by it. Light conditions in greenhouses should be carefully studied. Greenhouse management is intensive agriculture and the amount of capital invested in structures and maintenance is considerable. The returns should be the greatest possible, which means that advantage should be taken of every factor which increases the efficiency of the house.

As has been observed, carbon assimilation is proportionate to light intensity. Therefore, for most greenhouse crops, an increase of light increases the ability of the plants to assimilate food and to make a more rapid growth and development.

Among the things to be considered in improving the light conditions of greenhouses, may be mentioned the following: placing the houses so they will get the maximum amount of light during the day; giving such an angle to the pitch of the roof as will allow the sun's rays to strike the glass more nearly at right angles; eliminating shadows from eaves and overhead pipes; using larger and better glass; laying glass so that there is a minimum amount of lapped area; reducing the amount and size of the wooden parts of the superstructure; building larger houses and eliminating partitions from the interiors.

113. **Efficiency of morning light as compared with afternoon light.** — Experiments made at the Massachusetts Agricultural College seem to prove that morning light is more efficient than afternoon light. In Bulletin No. 144, of the Massachusetts Experiment Station, on the "Relation of Light to Greenhouse Culture," George E. Stone writes as follows "Mr. Alexander Montgomery, of the Waban Rose Conservatories, Natick, Mass., and a very skilled observer of plants, has for years believed in the superiority of morning over afternoon light, and many of the Waban rose houses were purposely placed fourteen to twenty-two degrees north of east instead of exactly east and west. In this position, the houses are tilted towards the sun, and the plants receive the morning sun more directly, which also makes it possible to syringe thoroughly."

TABLE I, SHOWING DIFFERENCE BETWEEN MORNING AND AFTERNOON LIGHT IN THE GREENHOUSE. EXPOSURE FROM 9 A M TO 12 M AND 12 M TO 3 P.M

MONTH	PERIOD OF EXPOSURE		PERCENTAGE OF INCREASED VALUE OF MORNING LIGHT
	9 A M — 12 M	12 M — 3 P M	
November	2282	1818	20.0
December	1074	0787	27.0
January	1322	1309	.9
February	2578	2396	7.0
March	2210	1867	15.0
April	2250	2033	9.6
May	3035	2622	13.0
June	3300	3023	8.3
July	3280	3174	3.2
August	3058	2845	6.0
September	3359	2928	12.0
October	2603	2287	12.0
Average	2529	2257	10.7

By means of chemical substances which are quickly acted upon by light rays a series of observations were carried on to determine the relative values of morning and afternoon light. These are recorded in this bulletin on previous page.

“The experiments shown in Table I, which lasted one year with practically no interruption, were made in a greenhouse twelve by forty feet, running east and west. This was an even-span house with the usual roof slope (30°), and was about eighteen years old. Eight years before these records were made, it had been remodeled and glazed with No. 2 double thick greenhouse glass, 16×24 inches. The sides had the original glass, about 12×22 inches. The light records were taken from 9 A.M. to 12 M. and from 12 M. to 3 P.M. at a point about four feet from the roof, and five feet from the south end of the house, and in all cases showed a greater percentage of light for the morning than the afternoon; the average for year, based on monthly averages, being 10 per cent in favor of the morning light. The greatest difference is shown in November and December, where the percentage (daily average) is 20 and 27 respectively; while the smallest difference (only .9 per cent) is shown in January.”

CHAPTER IX

PLANT REPRODUCTION

THE three principal ways in which florists' plants may be propagated are: by seeds, by cuttings and by grafting. There are various modifications of these, such as leaf cuttings, budding, inarching and layering, but they are rarely practical under glass.

SEED REPRODUCTION

The chief function of a plant is to multiply its species, and as a rule, when it has accomplished this purpose, it dies. Reproduction of a species is in a large measure dependent on the production of flowers and the resulting seeds. Natural reproduction is, for the most part, confined to this process.

Seed reproduction is an exhaustive process to members of the vegetable kingdom. As has been stated, many plants die after it has been accomplished, and in all cases, seed reproduction is detrimental to the vigor of the plants. Therefore, the problem of the flower-grower is to prevent seed formation, and still to foster in every way possible, the production of flowers, while maintaining strong, vigorous plants. This is essential so that the taking of cuttings and other asexual methods of reproduction may be practiced without detriment to either the parent plant or the offspring.

114. Value of the process to the flower-grower. — If all plants could be reproduced by cuttings, it would be a far simpler process than to resort to seeds. The production of some species of plants from seeds is a slow process, and plant-producers cannot use this method when many young plants of this species are required. A large number of cuttings can usually be rapidly made from an individual parent, and the cuttings will reach maturity much more quickly than will plantlets from seeds. Young plants from cuttings are, as a rule, more floriferous than are those from seeds.

The flower-producer should, however, increase the vitality of his plants from time to time. Constant reproduction of a variety by asexual methods and the abnormal conditions under which the offsprings are grown tend towards a deterioration of that variety. This is observed in carnations and chrysanthemums. A constant effort is necessary to preserve the standard of blooms, and this is accomplished by the introduction of "new blood." If care is taken to select the parents wisely, there will result a more vigorous offspring. Therefore, seed production is necessary for increasing the vitality of a species.

In the second place, certain plants will not reproduce by asexual methods; in palms, for example, reproduction by seeds is the only method the palm-grower can follow.

Some annual plants, however, will reproduce offspring from seeds more quickly than from cuttings, and these have characters similar to the parent. The flower-grower sows the seeds early in the season and has many flowering plants of desired varieties for spring sales. Dwarf forms of sweet alyssum and ageratum, *Salvia splendens* and many other plants belong to this class.

115. Season of the year for sowing seeds. — Every

methodical flower-grower will have a definite time for sowing certain seeds. The time depends, to a large extent, on the character of the seed coat and the length of time necessary to develop the plants. Most of the palm seeds are imported, and they arrive at different periods of the year, depending on the fruiting season in their native habitat. They should be sown as soon as received to prevent a hardening of the seed coat. Those which arrive in January, such as the cocos palm (*Cocos Weddelliana*) and the areca palm (*Chrysalidocarpus lutescens*), are sown in January; while the kentia palms (*Howea Belmoreana* and *Howea Forsteriana*) are sown in July.

The blooming period governs the time of sowing many annual plants. Seeds of cinerarias for spring-flowering plants are usually sown about the last of June. As the period of bloom of these plants is of short duration, another lot of seeds is sown in July for flowering later. Pansy seeds are usually sown about the first week in August so that strong plants may be ready for transplanting in September. These plants will become established before winter and be ready to flower with the first warm spring days.

Seeds of verbenas, centaureas, salvias and other annuals which come to maturity slowly, are sown in January. This gives large plants ready to bloom as soon as planted for early summer effects. Seeds of biennial and herbaceous perennial plants, such as lark-purs, foxgloves and hollyhocks, which are to flower in July or August, are also sown in January. Otherwise, they would not flower until the second season.

Most of the seeds of annual plants are sown the last of March or the first of April. As soon as they have developed sufficiently, they are transplanted into cold-

frames, so that a strong, sturdy growth results. If sown too early in greenhouses, the plants show a weak, spindling growth.

When carnations are propagated from seeds for the production of new varieties, the crossing is usually begun in November. The resulting seeds are sown as soon as they have matured. The plants may then be planted in the field early in the season and the flowering period will begin there. The propagator then forms an opinion of the value of the result of the cross and thus determines which plants promise well for further trial under glass.

116. Dormant period of seeds. — Each seed contains an embryo, or vital part. It also contains reserve food to nourish the embryo in germination or until it is able to get nourishment from the soil. The dormant period varies with different species. As a rule, seeds which contain large quantities of oil lose their germinating powers much more quickly than do those which contain starches. To preserve seeds, it is necessary that they be kept from moisture. With the application of heat and moisture, the enzymes, or those agents in the plant cell which have the power of changing starches to sugars, become active. The sugars are transferred from cell to cell, stimulating protoplasm into activity so that cell division goes rapidly on and growth results. This accomplishes what the flower-grower knows as germination of seeds.

117. Requisites for germination. — As has been stated, two of the principal requirements of seeds for germination are heat and moisture. They also require the free oxygen of the air.

The amount of water required and the degrees of temperature necessary for seed germination vary according to the species. Some seeds germinate in a com-

paratively dry soil, the portulaca for example. Others require abundant moisture, among these plants are nelumbiums and cannas. The larger number of seeds, however, require a moderate amount of moisture, and it is important that this amount be constant, especially after germination begins. A carnation-breeder may lose a season's work simply by neglect of his seedlings at this critical period.

Some seeds will germinate only under cool conditions, for example the pansy, others require a high temperature in which to begin growth. Palms and other tropical plants belong in this last class.

Most species of plants have definite temperature requirements for growth. A safe rule to follow is that the seeds should be placed in the same temperature as that required by mature plants of that particular species.

The two factors, moisture and heat, are not sufficient to produce germination. If seeds of some species are planted deeply in warm, moist soil, they will decay. Germination never results. Protoplasm to be active must have oxygen, and ordinary soil water rarely contains enough free oxygen to allow germination to take place.

118. Practical suggestions for seed sowing. -- In sowing seeds, the following practical suggestions will increase the number of seedlings from a given quantity of seeds:

Compacting soil. -- Always compact the soil about seeds to hasten germination. The seed coat will absorb water much more rapidly if it is in direct contact with a moist medium. If, however, the soil is very moist, as in seed sowing out of doors in early spring, the soil should not be compacted as much as later in the season when the surface soil has become drier.

Watering. -- Water seed boxes as soon as sown, provided they have not been watered by sub-irrigation methods

before sowing. Neglecting to do this may prevent the germination of expensive seeds. Moisture assists in rupturing the seed coat. It also causes the protoplasm to become active.

Temperature requirements. — Place in a temperature similar to that required by the matured plant of that particular species. Carelessness in this may stunt the growth of developing seedlings, even if germination is not prevented.

Drainage. — Provide good drainage so that the space between soil particles will not be filled with water, and the free oxygen of the air thus excluded.

Maturity of seeds. — Sow seeds as soon as possible after they are mature, to prevent the hardening of the seed coat and the drying out of the tissue beneath.

Rapidity of growth. — Encourage rapid germination of seeds by giving proper environmental conditions, so that algæ and other troubles may not destroy their germinating power.

119. Seed testing. — Seed testing is of great importance to the flower-grower, for often he should have a quantity of plants fully matured at a certain date. This may be the case at a holiday season, such as Easter or Christmas. If a planting of seeds fails to germinate, it may mean a large financial loss.

Many times, seeds do not germinate even when given the proper environmental conditions mentioned. This may be because the seeds are not sufficiently matured when collected. Expensive pansy seed, for example, is hand picked, and great care is taken to have every capsule matured and ready to burst, before gathering. When cheap pansy seed is placed on the market, the probabilities are that the plants have been pulled, spread on a cloth

and dried. The seeds which are liberated are then collected and sold. Some are mature but many are valueless. Often seeds may have been frosted while yet immature or before they have dried sufficiently, and this renders them liable to low germinating power. They may have been damp when gathered, and consequently subjected to heating later, or they may have been attacked by insects.

It is not necessary to sow seeds in soil in order to test their germinating power. A simple seed tester consists of two circular pieces of clean cotton flannel, a plate and a pane of glass. The cloths are dipped in water, and squeezed a few times while under water to press out the air. They are then left moderately wet and one is spread over the bottom of the plate. The seeds to be tested are placed on this cloth and covered with the other. The plate and cloths are next covered with the pane of glass to check the evaporation, and then placed in a temperature required by the species. The seeds should be examined frequently and removed as they sprout. A definite number should be tested so the percentage of viable seeds may be determined. The cloth should be boiled before using a second time, in order to destroy any molds which might develop and interfere with the germination of other seeds. There are several elaborate seed testers but the arrangement described, serves for most seeds.

120. Time required for germination. - The time required for germination varies greatly in different species of plants, and there is also a great variation even in seeds of the same species and variety. In primroses and petunias, for example, many of the choicest colors will not germinate until long after the less attractive colors have produced strong seedlings. For this reason, it is better not

to transplant seedlings too quickly, thus giving the weaker seeds time to germinate before the soil is disturbed.

121. Relation of size of seeds to vigor of the resulting plantlet. — The vigor of the resulting plantlet is generally in proportion to the size of the seed. This is true not only between seeds of different species, as for example, pea and petunia; but it is true of different seeds of the same variety. The plumper and larger the seed, the stronger will be the resulting plantlet. Plants show a strong tendency to inherit the traits of the parents, hence it follows that seed-producing parents should be strong and healthy.

122. Depth for planting seeds. — The depth for planting seeds varies with different seeds and with their requirements for soil moisture. Since the plantlet must force its way through the soil, other things being equal, the less energy required and the shorter the time needed to reach the surface, the stronger the vitality of the resulting plantlet. Therefore, seeds should not be planted deeper than is necessary to insure the proper supply of moisture. Many seeds will not germinate if they are covered at all. The rule, however, is that seeds should be covered to a depth about twice the diameter of the seed.

123. Soil for seeds. — A good potting soil, or one which has been used for some other crop like carnations, is quite ideal for seed sowing. It should have a liberal sprinkling of sand to insure good drainage. If it contains some finely sifted leaf-mold, the physical condition of the medium will be better. Pans or flats may be used; pans are preferable when only a few seeds are sown, but flats should be used for larger numbers. There should be good drainage in the bottom of the flat or pan. Above this, there should be an inch of coarse litter, and then the soil should be compacted over this, making sure that the

spaces between the drainage are all filled so that after the soil is watered and the seeds sown, there will be no settling of the surface. No fresh manure should be used in soil for seeds, for the roots as they develop are very delicate, and burning will result. The soil should be sifted and the seed bed should be made perfectly level. It is a good practice to water the soil before the seeds are sown, so there is an abundance of moisture in the bottom of the box. Let the seed box stand several hours, or until the surplus water has drained off; stir the surface soil slightly and sow the seeds.

124. Seed sowing. — Seeds should be sown evenly and thinly enough so that the seedlings may have enough light, and will not spindle and make a weak growth. No definite directions as to thickness of sowing can be given. Much will depend on the judgment of the sower. After the seeds are sown, they should be pressed into the soil with a smooth block, care being taken to clean the block after each variety of seeds is sown, so that there may be no mixing of species. A thin layer of soil should then be placed over the seeds, using a soil mixture of one-half sand and one-half leaf-mold. This light, porous mixture will prevent the soil from crusting. The surface should be moistened with a fine spray, and a pane of glass put over the flat or pan, to prevent evaporation of moisture. The glass should be covered with a newspaper, kept moist, to exclude direct sunlight, and the flat or pan placed in such a temperature as is required by the species. A temperature of 45° or 50° agrees with most species of annuals and perennials. Tropical seeds demand a temperature of from 65° to 70° . As soon as the seedlings begin to break through the soil, the paper should be removed, and the glass tilted a little to admit air.

REPRODUCTION BY CUTTINGS

Many plants have the ability to reproduce asexually through the use of special buds. These may develop on the root, stem or leaf. By far the larger number of greenhouse plants are reproduced through the agency of special buds formed on various parts of the stem.

125. Kinds of stem cuttings. — Different species of plants vary in the ease and rapidity of reproduction by stem cuttings. As a rule, those plants which make a comparatively rapid growth and which, therefore, have soft, succulent tissue, reproduce easily by cuttings. On the other hand, those species which are of slower growth and which have a harder, more compact cell structure, reproduce in this way with less ease. The method of making cuttings varies with the hardness or compactness of the tissue, and they are therefore classified as hardwood cuttings and softwood cuttings.

Hardwood cuttings. — Hardwood cuttings are seldom made of greenhouse plants. The method is more generally employed in propagating shrubs and other hardy, woody plants.

Softwood cuttings. — Softwood cuttings are quite generally used in the propagation of such plants as chrysanthemums, carnations, most bedding plants, and others of a like nature. The method of making these varies in many species, but the same rules may be given for all greenhouse plants.

126. Plants which may be propagated by softwood cuttings. — As a rule, all plants grown under glass which naturally produce many buds on the stem surface may be easily propagated from cuttings. If the plants show a tendency to produce roots at the nodes of the stem, the

ease of this method of reproduction is more pronounced. For example, if an injury occurs to a carnation stem near the base, roots will be formed there quickly, provided moisture and temperature conditions are correct.

127. Texture of material — In selecting material for propagation by cuttings, it is essential that it be of the right degree of maturity. Very recent growth is generally too soft or watery to give good results. The cell structure is not sufficiently firm to develop a root system, and there is not enough reserve food in the tender growth to nourish the cuttings. Therefore, wilting occurs and the cutting dies. Cuttings of new growth are also more likely to be attacked by fungous diseases because of the soft, succulent character of the stem structure. On the other hand, if the tissue is too hard, the protoplasm of the cell contents is more dormant; therefore, bud development goes on slowly. The rooting process is also retarded because of this, and the reserve food in the stem is often exhausted before the new plant is able to absorb nourishment through the root-hairs. Moderately firm structure such as will be found a short distance from the terminal bud should therefore be chosen for cuttings.

128. Position on the parent plant. — In some cases the part of the plant from which the cutting is taken has a marked influence over the value of the cutting. In the carnation, for example, cuttings taken from near the base of the plant are considered "grassy" by the propagator, and at maturity they do not produce sufficient flowers. On the other hand, cuttings taken from the side shoots high on the flower stem produce weak, spindling plants, which quickly shoot up into a flower stalk. Therefore, cuttings taken about halfway up the stem are preferred (Fig. 18, left). In chrysanthemums, strong

short-jointed shoots from near the base of the plant are considered best for propagation.

129. Essential characters of cutting material. — In the seed, the vital part is the embryo, while surrounding this is an abundance of reserve food for its nourishment until roots have developed. In the cutting, the vital part lies in those specialized cells which constitute the bud; this is the growing-point.

It is important in making the cutting to take with the bud some plant tissue from the parent. This tissue contains reserve food, and serves to nourish the growing-point for a short time during the process of the formation of roots. This tissue also has the power of assimilating new food through the agency of the chlorophyll bodies of the leaf and the carbon dioxide taken in through the stomata. There should, therefore, be enough of this extra cell structure to keep up protoplasmic development during root formation. Still, there should not be too much leaf surface, or transpiration of moisture will be too rapid, and wilting of the cutting will result.

130. Conditions essential for successfully rooting cuttings. — Correct soil temperature and moisture, atmospheric temperature and moisture, light and a proper amount of plant food are necessary for rooting cuttings successfully.

Soil temperature. — Protoplasmic development and consequent growth go on most rapidly under warm, moist conditions. Therefore, it is necessary that the temperature of the medium in which cuttings are placed be warm. The degree of temperature varies with different species, but as with the germination of seeds, it should be about the same as that required for the development of the matured plant. In rooting cuttings, it is essential that

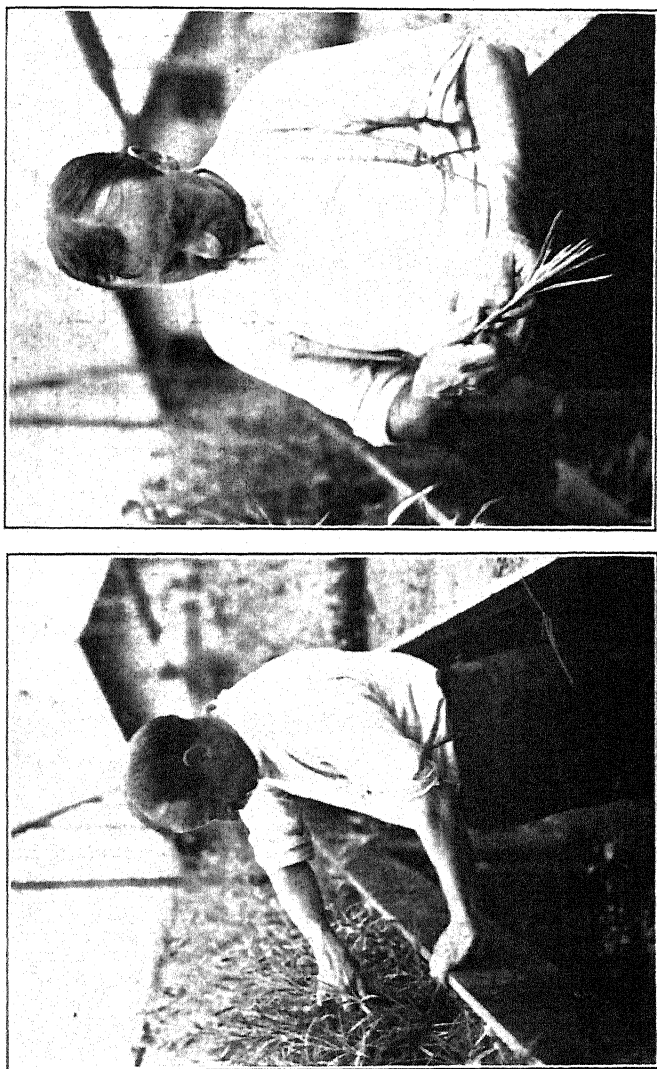


FIG. 18. — Left. Removing the cutting from the parent plant. Right. Preparing the cutting for the cutting-bench.

cell development be more rapid at the base of the cutting than at the tip. Development of the growing-point should, therefore, be retarded until root-formation has occurred. Because of this, a soil temperature several degrees higher than the atmospheric temperature is essential.

Soil moisture. — While cuttings without roots have no means of taking in moisture, it is essential that they be placed in a moist medium so that cell growth may go on rapidly. The soil water should be uniform and there should be sufficient drainage so that it will be constantly changed that aëration may occur.

Atmospheric temperature and moisture. — A hot, dry atmosphere increases the rapidity of transpiration from the leaf surface and a cool moisture reduces it. As the cutting has no roots through which to take in moisture, and as it has no power of taking it from the air through the leaf, every effort should be made to retard the transpiration. A cool, fairly moist atmosphere should, therefore, be maintained in the cutting-bench.

Diminished light. — Under strong sunlight the physiological process in the manufacture of plant food goes on rapidly. When sufficient crude material is available from which to manufacture food, growth is rapid and the vigor of the plantlet is shown by its deep, green color. If there is a diminished supply of crude material, the chlorophyll bodies in the plant cell are broken down in strong sunlight, and a yellow, sickly appearance is consequently given the cutting. Strong sunlight also increases the temperature in houses; therefore, cuttings thrive better in partly diminished light. The amount of light required by different species during the rooting process varies. At no time should the cutting be allowed to spindle because of deficient light; on the other hand, the cutting should never

be placed in such a strong light that it wilts or becomes light green and yellow.

Plant-food contents of soil for cuttings. — When cuttings are placed in soil, they have no power of absorbing plant food from it. They must first develop a delicate root-system. The development of this system is retarded if there is a large amount of decaying organic matter in the soil. The cutting should have this food in a diluted form, just as an infant requires dilute nitrogenous substances during the earlier years of its development. This nourishment is given the developing roots through the water which is applied. Therefore, the medium in which cuttings are placed should contain little plant-food.

131. Controlling environment of the cuttings. — To give cuttings the conditions best suited for the development of roots, special cases or rooms should be provided. These are propagating cases, or special propagating houses. The environmental conditions, such as soil temperature and the like, can then be more accurately controlled.

Soil temperature. — Soil temperature is controlled in propagating houses by means of additional pipes placed underneath the benches. In older propagating houses, these pipes were generally inclosed by boarding the front of the area under the benches. Usually this area had doors to permit ventilation and heat regulation. This produced close, confined air conditions which fostered the development of disease in cuttings. It is considered better to have a flange on the lower side of the board which fronts the bed, or to have a drop curtain for retaining the heat as it rises from the pipes underneath the propagating benches.

That the heat may not be too intense at the base of the cuttings, the bottom of the bench is often made of tiles or bricks, and the pipes are placed six or eight inches below

them. This equalizes the heat, and moisture from the bench is not dried out.

Soil moisture. — Soil moisture is increased by placing a layer of sphagnum moss over the tile or bricks at the bottom of the propagating bench. The moss has a peculiar cell structure which permits it to absorb large quantities of moisture, and to hold it in reservoir-like cells. It should not, however, be thick enough to prevent free drainage from the medium in which cuttings are placed. Careful attention should be given the watering of the cutting bench. At no time should it be allowed to become dry or even partially dry.

Atmospheric temperature. — Atmospheric temperature is controlled principally by ventilation and by the shading of glass. As a rule, the atmospheric temperature should be ten degrees lower than the soil temperature about the cuttings. All drafts over the cutting bench should be prevented, for they not only check uniform growth in cuttings, but they increase rapidity of transpiration. They may also foster disease.

Atmospheric moisture. — Atmospheric moisture is controlled by having a low roof over the cutting bench and by frequent dampening of the walks and the area underneath the benches. Careful attention should also be paid to ventilation, which has a marked effect on atmospheric moisture. Too moist an atmosphere, however, favors the development of fungous diseases, especially the "damping off" fungus, and so should be guarded against.

Light conditions. — Ideal light conditions over cutting benches come from a northern exposure. If the bench is so located that it may get the early morning and the late afternoon sunshine, most healthful conditions will be produced. Cuttings, when first made, should always be

shaded from direct sun. This may be done by using cheesecloth drop-curtains, or by placing newspapers over them. The cheesecloth is preferable.

Soil medium. — The soil medium in which cuttings are placed should be carefully selected. A moderately fine, sharp sand is considered the best. This should be absolutely free from decaying, organic substances. The sand should be compacted firmly and the bench filled to the top, so that there are no confined, atmospheric areas around the cuttings.

132. Equipment for making cuttings. — A clean, sharp knife; a flat, in the bottom of which a moist newspaper has been placed; a wooden block of two-by-four inch material, which has been planed on at least one surface; a straight-edge, about an inch and three-quarters wide, a half-inch thick, and as long as the width of the cutting-bench; a putty knife; a watering can with fine sprinkler.

133. Methods of making the cutting and inserting it in the sand. — Select strong, healthy, terminal shoots. Cut them from the parent plant, having them a little longer than the cutting is to be. Place in a flat on moist newspaper. Remove to a shady potting-shed and prepare immediately for the cutting-bench. Do not take enough from the parent plants at one time to necessitate delay in placing the cuttings in the sand. They should never be wilted when thus inserted. Have the knife perfectly sharp. A smoothly cut area heals much more quickly than does an area torn with a dull knife. Make a smooth cut straight across the base of cutting in an area where the tissue is of proper maturity to facilitate rooting quickly (Fig. 18, right). Reduce the leaf area sufficiently to diminish rapidity of transpiration. Drop the cuttings in a flat with moist paper in the bottom. If many cuttings are to be made

before they are inserted in the propagating bench, the cuttings should be covered at once with moist newspapers. Take them to the propagating-bed. Compact sand firmly and evenly. Lay straight-edge on the sand and hold it firmly in place. Draw the putty knife through the sand, deeply enough so the cutting may be inserted firmly, having the space wide enough so no injury to the tissue will be made by crowding (Fig. 19, upper). Space the cuttings far enough apart to insure good air circulation about the base. Press sand firmly about the base after one row has been inserted. Level the sand, again placing the straight-edge on it, and having one side next to the row of cuttings. Rap sharply with the putty knife, to level the sand between the rows of cuttings, then open another groove to receive a second row of cuttings as before.

After a few rows have been inserted, water thoroughly, and shade with newspapers to prevent wilting. "Always remove the newspapers after sundown, and in one or two days they may be discarded entirely. If left on too long, conditions which favor disease are produced.

Use fresh sand for each batch of cuttings. When the sand has been used once, it should be thrown out, but after exposure to heavy freezing, it may be used again.

134. Length of time cuttings should be left in sand. — Serious injury results if cuttings are left too long in the propagating-bed. There should be a gradual increase in the quantity of plant-food in the soil medium. The water which is given the cuttings from time to time contains sufficient plant-food to nourish them until roots one-quarter to one-half inch in length are formed (Fig. 19, lower). The dark green color of the foliage indicates that roots have formed, and the cuttings are then in a condition to assimilate more nitrogenous plant-food. If this is not



FIG. 19. — Upper. Inserting the cutting in the propagating-bench.
Lower. Removing the rooted cutting.

given, cell development is checked, and the cutting becomes hard and woody. Rapid growth cannot go on, and the young plantlet becomes stunted and weakened. Cuttings should never be left too long in the propagating bench.

REPRODUCTION BY GRAFTING

Within recent years, reproduction by grafting has come into popular favor in greenhouse work, particularly with rose-growers. For many years, all roses forced were grown on their own roots. There was an apparent lessening of vitality in the plants and consequently a lower production.

An attempt was made to graft tea roses and hybrid teas on various kinds of native rose stocks. After many failures, a satisfactory union finally resulted from the cions on the manetti stock. This stock is grown extensively in England, Scotland and France. This method of grafting roses was first introduced by Alexander Montgomery at the Waban Rose Conservatories in Natick, Massachusetts.

135. Advantages of grafted rose stock over own-root stock. — For several years, there has been much controversy between the advocates of using grafted stock and those of using own-root stock. A consensus of opinion favors grafted stock. The reasons are as follows:

(a) Freedom from attacks on roots by nematode worms.

Attacks from nematode worms are very likely to occur when roses are grown on their own roots. This rarely occurs on grafted stock, hence healthy plants are produced and a consequently larger output is assured.

(b) A longer blooming period because of increased vitality in the root system, so that plants may

be forced in the same soil for several years. One large grower estimates that it costs him ten thousand dollars to replant his houses. If this expense can be eliminated by carrying the same plant over for two or three years, the financial results certainly favor the use of grafted stock.

- (c) A larger production of uniform-sized blooms.
- (d) Larger, stronger plants for summer planting, consequently a larger number of blooms early in the fall. In an excellent pamphlet written by Alexander Montgomery, Jr., this topic is discussed.

136. Importation and preparation of manetti stock. — Manetti stock is generally received in this country in December or January. After it has become dormant in those countries where it is extensively grown, it is dug, placed in bundles of about twenty-five, and the roots wrapped in straw. In this condition, the stock is shipped to the United States. As soon as it arrives, it is hurried through the custom house by the importers and sent immediately to the ranges. It is unpacked and "heeled in" for a few weeks in a cool, moist cellar. This freshens the tissue of both roots and stems, and they become plump and firm. Fresh white rootlets soon appear on the dormant roots. The stock is then ready for potting, two and one-half inch pots being used. Stock plants are planted very firmly in a moderately rich compost, and placed in a temperature of about forty-five degrees. As soon as root growth commences and the buds begin to swell, they are ready for grafting (Fig. 20, upper).

137. Construction of the grafting case. — Unlike other forms of grafting, no grafting wax is used to protect the union of stock and cion. A warm, moist atmosphere is

all that is necessary to prevent drying out. The temperature and moisture conditions should be under perfect control, and a perfectly tight grafting case is required. This is usually built on the greenhouse bench, in a partially shaded position, and about twelve inches high at the front, to about eighteen inches high at the back. The sides are made of wood and the top is glazed. Frequently a hotbed sash is used for the top and is hinged at the back (Fig. 20, middle).

There should be excellent facilities for controlling bottom heat, for a uniform bottom temperature of 75° should be maintained. It is also essential that the case be perfectly tight.

About four inches of coal cinders are placed in the bottom of the grafting case and thoroughly wet. It is from this source that the young grafted stock obtains moisture for the first five days, hence the importance of a sufficient amount of water in the cinders. If too wet, the atmosphere of the case will be too moist. Drops of water will accumulate on the surface of the leaves, producing mildew. If the cinders are too dry, the foliage of the cion will shrivel and die.

138. The preparation for grafting. — When ready for grafting, a flat filled with manetti stock in two and one-half inch pots is brought from the greenhouse and placed on a low bench in front of the grafter. A bundle of raffia, which has been cut into lengths of about eight inches, is also placed on the bench. The person doing the grafting then takes a flat, puts moist paper in the bottom, and goes to the rose house to select his cions. This selection requires excellent judgment. The material for cions should not be too hard or it will not make a speedy union with the stock. If too soft, it will be lacking in reserve

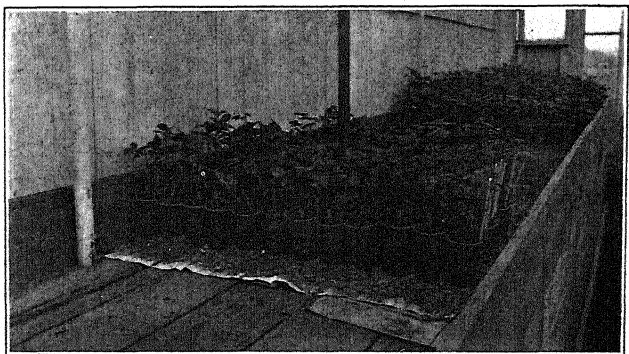
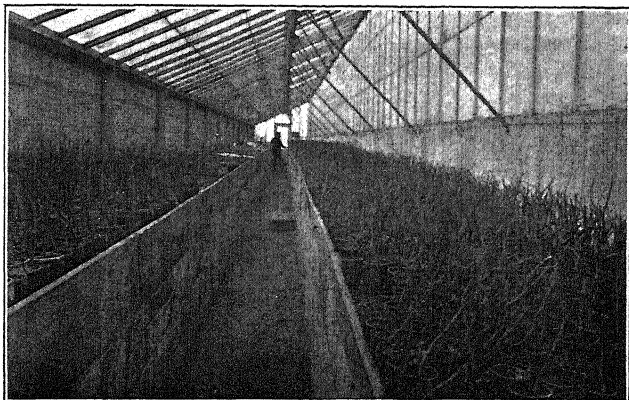


FIG. 20.— Upper. Manetti stock ready for rose grafting. Middle. The grafting case. Lower. The grafted stock.

food and will wilt quickly. Wood taken from the last few nodes of a flower stem usually produces the best results. Many propagators use "blind" wood. The selected wood for cions is taken to the grafting room.

139. The grafting process. — The man who is to do the grafting seats himself on a low stool. The table or bench should be about four inches above the grafter's knees. He takes one of the potted stock firmly in his left hand, and with his right hand, he draws a slanting cut upward with a sharp knife. Care should be taken not to pull the stock from the soil, nor even to loosen it. Any great strain will injure the feeding roots. The knife should be perfectly sharp so that the pith is cut smoothly and the tissue not torn. A similar cut is next made on the cion. The length of the cion depends on the length of the nodes, but it should not be more than one and one-half inches long. Most propagators leave but one bud on a cion. The leaf area is reduced to lower the transpiration from the tissue until stock and cion have joined.

The cion is held firmly against the stock, care being taken to place it so that the cambium layer at the base of the cion and at the base of the cut on the stock are joined, also that the cambium on at least one side of stock and cion meet. The stock and cion are firmly held together with the thumb and forefinger of the left hand while they are wound tightly with raffia by the right hand. The winding extends from the upper part of the graft downward. This raffia should not entirely cover the cut surface, for it is necessary that the cut area get a little atmospheric oxygen to hasten the healing process. It is essential that the union be as perfect as possible. Often the stock and cion join, and there is an apparently healthy union, but if care has not been taken to place all parts of the cambium

layer of stock and cion in contact, the physiological flow of sap is retarded. This becomes apparent later in the process of development, by the formation of a gall-like body at the junction of stock and cion. After the grafts are wound firmly, the plants are ready for the grafting case in which they should be placed before they show any tendency to wilt.

140. Manipulation of the grafting-case. — The grafting-case should be divided by cross partitions into a sufficient number of sections to hold the plants grafted in one day. As soon as the grafted stock is placed in the case, the cover is lowered and fastened firmly that no outside air may enter. The cover is not raised for at least five days unless it is found that too much moisture is accumulating on the foliage, then it should be raised only the thickness of a plant label, for a very few minutes. After five days, a little air may be given for perhaps ten minutes in the morning and the same in the afternoon. The following day a little more air is allowed to enter, and the periods of ventilation are gradually increased until full air is given. This period is the most critical in the grafting process, and it requires exceptionally good judgment on the part of the propagator to carry the grafted stock successfully through.

141. Treatment of plants when they are removed from the case. — At the end of three weeks, stock and cions should be joined sufficiently to permit them to be taken from the case. The plants are then placed on a greenhouse bench with low sides (Fig. 20, lower). They should never be placed in a deep bench, where atmospheric conditions are necessarily inferior and where disease is liable to infect the point of union. Also, in a deep bench it is almost impossible to syringe the lower sides of the leaves to prevent the attacks of the red-spider.

OTHER FORMS OF REPRODUCTION

Reproduction by other forms, such as budding, layering, and the like, is used to such a limited degree in ordinary greenhouse work that it is considered unnecessary to discuss it in detail. There are several books on plant culture which treat specially of propagation. Among them are "Principles of Plant Culture," by E. S. Goff; Oliver's "Plant Culture," and the "Nursery-Book," by L. H. Bailey. Students and readers are referred to them.

CHAPTER X

SOIL FOR GREENHOUSES, ITS FERTILITY AND PREPARATION

THE success or failure of the flower-grower depends in a large measure upon the character of the soil. In the larger number of cases where plants are unhealthy, and results unsatisfactory, soil conditions are responsible.

As has been stated in Chapter VIII, healthy root growth and development cannot take place unless soil moisture, heat and aëration conditions are correct. In addition to these requisites, there should be proper amounts of plant food in forms that plants may readily use.

142. Classification of soils. — Soils are generally classified according to the size of the particles, as follows :

Fine gravel	2	to 1	mm.
Coarse sand	1	to 0.5	mm.
Medium sand	0.5	to 0.25	mm.
Fine sand	0.25	to 0.1	mm.
Very fine sand	0.1	to 0.05	mm.
Silt	0.05	to 0.005	mm.
Clay	0.005	to 0	mm.

143. — Value of the different classes in greenhouse work. — No one of these soils, if used alone, is ideal for the growth of any species of plants under glass.

When large numbers of plants are to be propagated by cuttings, however, it is necessary to have available an abundance of sharp sand of medium texture. This is es-

pecially true if one is to specialize in carnations, or if many chrysanthemums, roses or bedding plants are to be propagated by cuttings. Upon the ease with which sand may be aerated and its capacity to retain moisture, depends in a large measure the success of propagation. If sand of large particles be used, water drains from it quickly, and the amount of air which is admitted dries the tissue of the cutting before rooting takes place. On the other hand, if the sand is too fine, it retains moisture and excludes air to such an extent that healthy root action cannot begin.

The sand should be free from all forms of humus, otherwise the cutting bench fungus, known as "damping-off" fungus, will be prevalent and many cuttings will be lost.

As a rule, plants under glass grow best if the soil contains a mixture of medium sand, silt and clay. The proportions vary with different crops, and the plant requirements have to be studied carefully. They are learned largely by investigation and experimentation. Experiment stations in connection with the agricultural colleges and the United States Department of Agriculture have done much valuable work in determining correct soil conditions for various species of plants, but much remains to be learned.

144. Soil for violets. — In his book on violet culture, Galloway¹ discusses the matter of soils for violets as follows: "By varying the texture of the soil, its water content is varied, its capacity for heat is modified, and so on until every important factor, including food in the ordinary acceptance of the word, is involved. To these variations the plant adapts itself, and the results may be extensive leaf-development with few or no flowers, or *vice versa*, a

¹ "Violet Culture" by B. T. Galloway.

weakened condition of the tissues (making the plant subject to the attack of enemies, especially fungi), and so on through a list of other possibilities. To illustrate more fully, we may say that in our experience, the Lady Hume Campbell violet seems to thrive best on relatively light soil; that is, a soil which contains a comparatively small amount of clay. The Marie Louise, on the other hand, does best with more clay, or in other words, a heavier soil. The violet soils of the Poughkeepsie region contain from eight to fifteen per cent of clay, and it is here that the highest success is attained with this particular variety. In parts of Maryland and Virginia, where the Campbell violet is grown extensively, the soils frequently contain six to eight per cent of clay, so that it will be seen that there is considerable difference as regards the structure of the two classes of soils. It follows of course that where soils showing so much difference in structure are used, the plants in each case have different sets of factors to which they must adapt themselves, and in doing this they may be so modified as to materially affect the development of the flowers."

145. Mixing soils. — "Soils of both the heavy and moderately heavy types are found in many places, and if they do not occur naturally, the desired effects may be approximated by combination of light and heavy soils. We have never found it satisfactory to lighten heavy soil by mixing it with sand alone. This takes away the life of the soil, and plants never succeed so well in it as when the desired conditions are produced by mixing a heavy and a light soil. For example, we may have in one part of a field a soil containing fifteen to twenty per cent of clay, and in another, one containing four or five per cent. By mixing these two soils in equal proportions, a combination

is effected which, other conditions being equal, will prove better for violets than either soil used alone."

146. Sweet pea soil. — Soil suited for violet culture is also well adapted for growing sweet peas under glass.

147. Rose soils. — An ideal rose soil is one which contains about twenty per cent of clay, but the real value of such a soil depends also upon the percentage of silt and sand which it contains, as well as upon the amount of decayed organic matter. There should be sufficient sand in the soil, so that it is porous and not so compact that the roots cannot penetrate it easily. A soil which contains more than sixty per cent of silt and clay is known as a clay loam.

148. Soil for other crops under glass. — Carnations, chrysanthemums and bedding plants are not so particular in regard to soil conditions as are many of the other florists' crops. There are, however, certain soils which are better than others for these crops. Light, sandy soils are detrimental to plants because they retain so little water. Soils with a large percentage of clay are difficult to work, and are characterized as "cold soils." When crops require summer culture out of doors, as do carnations, it is essential that the soil naturally contain a proper proportion of sand, silt and clay.

149. Organic matter in soil. — Aside from the mineral particles, practically all soils contain more or less organic matter. The source of this comes largely from plant bodies in various stages of decomposition, but a certain percentage is derived from animals. These animals are mostly of the so-called lower forms.

150. Forest soils. — Forest soil contains large amounts of leaf tissue in various stages of decomposition, and this is known to the gardener as leaf-mold. Soils in which

decaying leaf tissue is present are most valuable from the plant-grower's viewpoint, for such soils are not only rich in various food elements which stimulate plant growth, but they render the soil porous and at the same time increase the water-holding capacity.

151. Value of soils from sod. — Sod land, especially pasture sod, is filled with fine, fibrous roots of grasses. Continual cropping by animals develops the area of root surface, and because of its large fiber contents, pasture sod is considered preferable to sod from mowings. Probably no other agent gives greater life or "vitality" to the soil than does a large amount of root fiber in various stages of decomposition.

152. Muck and peat soils. — Many low lands have been the dwelling place of mosses and other low forms of plant life. These have died, and gradually the soil has become filled with their decaying materials. These soils the flower-grower knows as "peat soils," and they are most valuable for certain types of florists' plants, particularly orchids. Peat is not particularly rich in available plant food, but because of its porosity, it makes an excellent medium for plants which require a thoroughly aerated soil. Muck, which represents a more advanced stage of decay, is less commonly used by florists. Often it is filled with organic acids which render it "sour" and unsuited for plant growth. If it is thoroughly composted with other soils, however, it becomes a most valuable soil medium for greenhouse plants.

The organic matter in soils varies much in its chemical composition. It is composed of many carbon compounds, into which enter nitrogen and all the mineral elements which are necessary for plant growth.

153. Chemical compounds in soils. — In discussing

the subject of organic matter in soils, Lyon and Fippin¹ in their book on soils, state: "These original (carbon) compounds are broken down in the process of decay into other successively simpler compounds. The end of the process is always essentially the same — the reduction of the elements to their simplest and most stable forms, the carbon to carbon dioxide, the nitrogen to nitrates, ammonia or even free nitrogen, and the mineral elements to their simple salts. The soil constituents, which are termed humus, mold, peat, muck, etc., merely represent stages in the transition process from the fresh materials to the native elements. There is no single compound or group of compounds which imparts definite characteristics. These are the result of the mixture, and this fact of an infinitely complex mixture is exceedingly important to keep in mind in considering the effects of the organic matter on the soil. Many of them are acid. Some, as ammonia and marsh gas, function as bases. They react with each other in many ways, and what is more important, they react with the mineral elements of the soil to form organic salts. It is by this union that organic matter has not only a direct effect as a food, but also an indirect effect in releasing food elements from their less soluble mineral combinations. Aside from the production of many complex, organic acids, the two most significant facts of their composition are the per cent of nitrogen present; and the chemical form of part of the carbon-nitrogen which is not a constituent of rocks, is made available in all higher forms of plants through this organic decay process, and these various compounds constitute the soil storehouse of the element, from which it gradually changes over into the available forms."

¹ "Soils" by Lyon and Fippin.

In considering the amounts of organic matter present in soils, the same authorities state: "In general, arid soils contain less organic matter than soils of humid regions; those of cold climates more than those of warm climates. The soils of the northern states and Canada are very generally quite dark colored, while those of the southern states under similar treatment are much lighter colored, due to difference in organic contents. Wet soils contain more than dry soils, and clay soils more than sandy soils."

Both the chemical and physical effect of organic matter on the soil are of great value to the plant-grower. As before stated, soils deficient in organic matter are lifeless. Organic matter renders clay soils lighter in character and more thoroughly aerated, it makes sandy soils more retentive of moisture, and better suited for healthy root action; it adds color to sandy soils, rendering them darker, thus increasing their power to absorb the heat of the sun's rays. From the chemical viewpoint, the presence of organic matter increases the direct food materials, and the formation of organic acids renders soluble many insoluble mineral elements in the soil, thus making them available for plant food.

154. Sanitary relations of soils.—In an excellent paper¹ on "Soil Problems of the Florist," E. O. Fippin states as follows: "I cannot fail to dwell upon the sanitary relations of the soil. It is now very well known that the whole question of fertility is not comprised within those positive processes of supplying plant-food or other factors for growth. With all these well supplied, plants may still fail because of the existence of some inhibiting

¹ A paper read before the New York State Federation of Floral Clubs at the winter meeting at Ithaca, N.Y., in 1914

influence within the soil. These inhibiting or unsanitary conditions may be divided into two or three groups:

“It is now pretty well recognized that in addition to the beneficial substances that result from decay of roots and other organic material in the soil, and from the action of microscopic plants, there may also be produced various poisonous or toxic substances which are injurious to the growth of the plant. It appears that one of the reasons why the continuous growth of a crop upon the same soil results in reduced yields, is the accumulation of the poisonous products of decay or secretion of the roots of that plant. It is coming to be understood that the products or toxic substances from one plant may not be injurious or may be even beneficial to another plant, and, therefore, in plant association this fact should be taken into account. It is a topic that requires much further investigation for the guidance of the practical man.

“One of the functions of commercial fertilizers may be to render less innocuous these toxic substances, for it is known that fertilizer substances by promoting or depressing oxidation and other changes render these toxic substances less harmful.

“It should always be known that the crop produced is competing with many other plants in the soil. We well recognize the importance of keeping down weeds which will compete with the main plant for food and moisture. But we have not given so much attention to the competition of the crop with the microscopic plants in the soil, the bacteria and the fungi. Instead of being a dead mass, the soil is teeming with life. In every grain of soil there may be millions of bacteria and many kinds of fungi and molds. These require the same food elements that the higher plants use, and it may frequently happen

that the soil conditions are as well, or perhaps a little better, suited to the development of these microscopic plants than to our higher plants, and they may gain the ascendancy and utilize the plant-food designed for the crop. This idea, too, is one of the recent developments in soil fertility. In England, Russell and Hutchinson have developed many facts showing that in their soil and especially in soils known to be sewer-sick, and in greenhouse soils that have come into a so-called sick condition, there may be the development of excessive numbers of the very simplest animals, known as protozoa, which compete with the plant roots and with beneficial forms of bacteria. They have developed facts which indicate that any treatment which kills or reduces the number of these competing organisms tends to promote the growth of higher plants, and in general, to create a better state of fertility. It should be pointed out that in the greenhouse where conditions are continually favorable for growth, such difficulties may become much more acute than in the field where the variations in climatic conditions and the changes in season, including freezing in winter, tend to hold such processes in check. It is found that partial sterilization by the use of heat or by chemicals has an important influence upon the fertility of such soil for some time thereafter, by killing certain of these competing organisms and by effecting other changes, such as those dealing with nitrogen. In greenhouse soil, with its usually large stock of organic matter, attention to lime, soil moisture, high temperature and other conditions favorable to biological processes, these difficulties may become exceedingly acute, and they may be promoted or affected by different kinds of fertilizers used. Another treatment that seems to have some bear-

ing on these questions, is the use of caustic lime, which material appears to have a certain sterilizing influence."

155. The availability of fertilizing elements. — As has been stated, the mineral constituents of a soil and the amount and character of the organic matter in it have much to do with its fertility. All mineral elements must be rendered soluble before they can be used by plants, and organic substances must exist in correct combinations before they are of value. A soil may contain a quantity of food elements and yet a plant may starve. For this reason, chemical soil analysis is seldom satisfactory. Many samples of soil are sent to experiment stations with requests that they be analyzed, and the grower informed in what particular fertilizing elements they are deficient for the growth of a particular crop. The chemist can determine the minerals which compose the soil, but he is not familiar with the food requirements of the plants and the availability of minerals for them. This is a problem to be determined only by experimentation for each particular crop and for each type of soil. It is essential that the flower-grower know the sources of plant food, and then treat his crops so that they will receive the proper amounts of nutriment. As has been stated, in addition to the food which plants take from the minerals of the soil, many plants absorb from the air an abundance of food in the form of carbon dioxide.

156. Elements essential for plant growth. — The composition of plant food is so well known by most plant-growers that it is hardly necessary to enter into a detailed discussion of this subject. The elements regarded as essential are hydrogen, oxygen, carbon, nitrogen, potassium, calcium, magnesium, phosphorus, iron, chlorine and sulfur. Certain plants make use of other elements,

but they are not considered essential. With the exception of potassium, phosphorus and nitrogen, these elements are present in most soils in sufficient quantities to meet the plant's need.

157. The preparation and use of fertilizing elements. — All fertilizing elements are absorbed by the plants in definite compounds such as water, carbon dioxide, nitrates, sulfates and others. It is the function of plants to take these compounds and to re-combine them into other compounds which are used by the protoplasm to build up plant tissue and to cause growth. For example, carbon is the chief constituent of vegetable substances, and forms about one-half their total dry weight. It is obtained almost wholly from air in the form of carbon dioxide. This carbon also combines with water which is absorbed by the roots, and various starches and sugars result. Water also furnishes the hydrogen and oxygen which enter into various other combinations which serve to build up plant tissue. Nitrogen is one of the chief constituents of the vital cell contents which form the material known as protoplasm. Nitrogen, therefore, stimulates growth.

The greater number of plants obtain their supply of nitrogen from soluble nitrates in the soil, but some few have the power of assimilating this supply directly from the air. Phosphorus and sulfur assist in the formation of albuminous substances found in protoplasm. They give color to the fruit and also stimulate seed production. Calcium and magnesium seem to be essential in the formation of cell wall structure. Potassium assists in the assimilation of food in the cell content, and also gives strength to the cell wall. Iron is essential in the formation of chlorophyll bodies in the cell sap.

Of the necessary elements required by plants, all are present in most soils in sufficient quantities for healthy growth except nitrogen, phosphorus and potassium. It is with these three elements, therefore, that the student of fertilizer problems for greenhouse plants must deal.

158. Preparation of greenhouse soil. — As is so frequently stated, culture of plants under glass is intensive agriculture. The area is limited, and the greatest possible production should come from the least possible ground area. Hence, every inch of soil should not only contain the maximum amount of nourishment, but it should be in such a physical condition that the plant food will quickly become available. The florist cannot have in his soil the large quantities of unavailable plant food which the fruit-grower possesses. He must so treat the soil that the insoluble compounds will be largely soluble when put into the houses. In other words, he should reduce to a minimum the bulk of soil in which he is to grow his crops throughout the season. This is necessary, not alone because of the added expense of handling large quantities of soil, but because in forcing plants into bloom it is essential that soil, temperature and moisture be under quick control.

159. Length of time required to prepare soils for greenhouse work. — It is necessary to begin the preparation of the soil a considerable period, usually a year, before it is to be used. This is because of the length of time required to render certain naturally insoluble, fertilizing elements available for plant food, and to decompose thoroughly artificial fertilizing elements. Climatic changes, especially freezing, are powerful agents in the preparation of the soil, and the more it is subjected to the action of the frost, the better are the results.

160. Methods of preparing soils.—There are two methods generally used in the preparation of soil for greenhouse benches. The first, and the one most commonly used on smaller ranges, is the compost method, usually known as the compost heap; the second method has more recently come into favor, especially with large rose- and carnation-growers, and is known as the field preparation of soil.

The compost method.—For small ranges where many varieties of plants are grown, the compost method is, without doubt, the most satisfactory. It is expensive, however, as it requires much hand labor, and unless the soil is frequently turned, there is a possibility that it may become sour. The compost heap should be conveniently located, and if the moisture contents can be governed, the results will be more satisfactory. Under dry conditions, sods decay slowly, and if it is necessary to hasten the process, the compost heap can be soaked occasionally with a hose.

As before stated, pasture sod is rich in its fiber content. If pasture sod which contains mineral substances in the right proportion can be obtained, it makes a most ideal compost. If such is not available, the sod should be selected from mowings which have been in sod for a considerable period. It should be pared off to a depth of four or five inches, and this should be done in the early fall. The sod is taken to the spot selected for the compost heap. It is piled in heaps about five or six feet high, six feet wide, and any desired length. Piles of this width can be turned easily and conveniently by two workmen. A layer of sod of definite thickness is followed by a layer of manure (Fig. 21). The thickness of this layer of manure depends on the fertilizing requirements of the crop to be

grown. Usually this is one to four; that is, after a layer of sod four inches thick, a layer of stable manure one inch thick is placed over it. Another layer of sod is then added, followed by a layer of manure until the whole is from five to six feet in height. Early in December this pile should be turned thoroughly, and the manure well incorporated with the soil. If possible, the compost should be turned once or twice during the winter and



FIG. 21. — A compost heap.

again in the early spring. Just before putting this soil in the benches, the compost heap should once more be turned, and at this time any additional fertilizers, such as bone meal or wood ashes, may be added.

Every range in which considerable propagating is done should have a second compost pile composed of sod alone. This soil is used to pot plants as they come from the propagating bench.

The field method. — The second method of soil preparation, which is quite generally practiced where large quantities of soil are needed, is to select a piece of sod ground, where the soil is of the right character, and to top-dress it in August with an even coating of stable

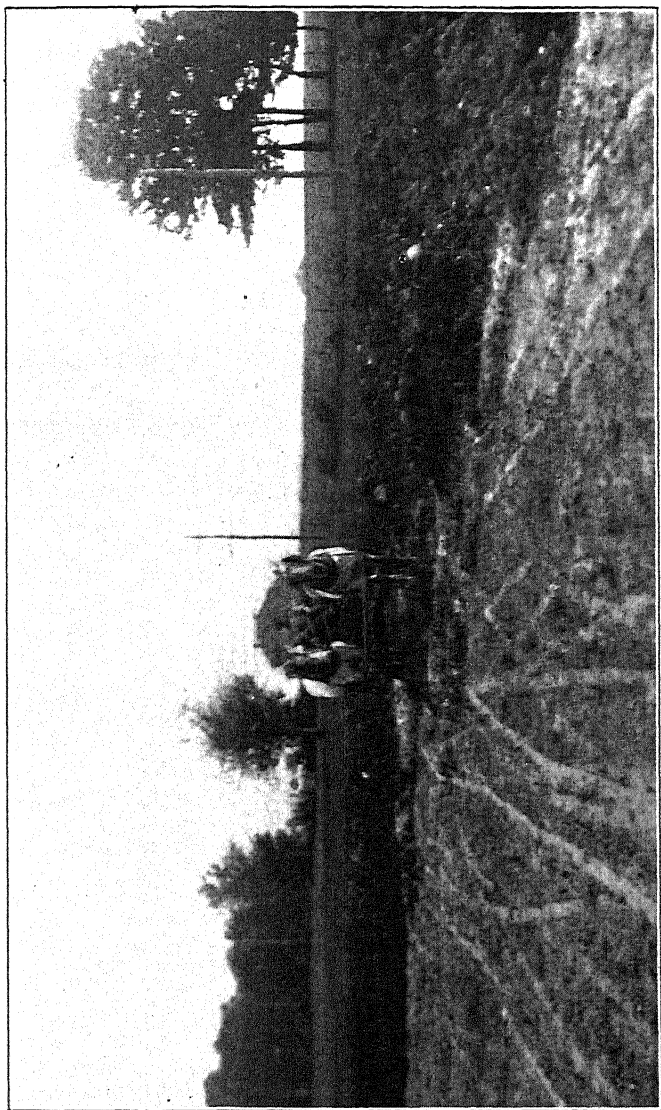


FIG. 22. — Preparing rose soil by the field method.

manure. This should average an inch or an inch and one-half in thickness. The area is then plowed to a depth of six inches, and left until near the middle of October. It is then again plowed and thoroughly gone over with a disk harrow. About the middle of November, or just before the ground freezes, it is once more plowed, and this time it is left in ridges so that frost may penetrate to every part. The freezing tends to kill insects which might winter in the soil. As soon as it is possible to work the soil in the spring, the area is plowed, and after a week or two it should be plowed again. It is next drawn into ridges so that alleys may be opened for carts, and then frequent disking is practiced. One successful rose-grower states that he disks his soil on an average of once a week from the time the soil is sufficiently dried in the spring until it is ready for the benches. This thoroughly incorporates the fiber and manure with the mineral particles, and renders all plant food readily available for the feeding roots. After the surface soil has been removed from a given area the next year sod soil may be carted on to this area and prepared as described (Fig. 22).

161. Utilization of waste material for fertilizers. — Every well-organized range should compost the waste of the range. Dead leaves and other waste materials from greenhouses make valuable fertilizing material after they have become thoroughly decomposed. When special crops are grown, care should be taken that leaves are not infected with fungous diseases which may not be destroyed in the decomposing process. This heap of waste materials should be wet and turned frequently to prevent rapid decomposition, which results in heating the material to such a degree that there is a considerable loss of nitrogen.

162. Leaf-mold. — Every range should utilize the leaves from the trees if there be any on the place. Leaves should not be burned, for it means a loss of valuable nitrogen. If there are shrubs to be protected, the leaves should be raked about them and covered with boards. In the spring, the leaves when removed from the shrubs should be piled while damp near the compost heap, again covered with boards, and allowed to decay as rapidly as possible. If turned occasionally during the summer, they should be decayed sufficiently so they may be thoroughly incorporated with potting soil in the fall or early winter. This leaf-mold is exceedingly valuable for plant food, for it renders nitrogenous food materials gradually available for plants, so that delicate roots are less liable to injury than from feeding on more actively decaying fertilizers.

CHAPTER XI

DISEASES OF FLOWERING PLANTS IN GREENHOUSES

DISEASE in plant tissue is caused by the action of minute plants or animals, as bacteria, fungi, insects or worms, living therein as parasites. These attack the host plant in various ways, and a malformation or breaking down of the tissue is the result. This constitutes disease. Diseased conditions may also result from unfavorable conditions of soil, water supply, temperature or from mechanical injury.

GENERAL CHARACTERS OF FUNGI

Fungi are plants which contain no green coloring matter. As they have no power of manufacturing their own food they obtain it from living parts of other plants, from the products of living bodies, or from dead bodies of plants or animals. The fungi which derive nourishment from the bodies of living plants or animals are called parasitic fungi; those which live on the products of living plants or animals, or on their dead bodies, are known as saprophytic fungi. The student of plant diseases works largely with the former.

All fungi are organized in a similar manner; first, a set of colorless filaments, either isolated or interwoven,

forms the main working body. These filaments are the mycelium. The mycelium is in contact with its source of food supply, known as the substratum.

163. Reproduction. — Parasitic fungi may be reproduced in three ways; vegetatively, by asexual spores or by sexual spores. In vegetative reproduction, a mycelial strand may be broken into several divisions. Under favorable moisture and temperature conditions, each division has the power of growth, increasing in size with more or less rapidity.

When reproduced by asexual spores, ascending branches arise from the mycelial tissue. From the extremities of these branches, independent cells are separated. These cells have the power of producing rapidly another mycelial strand if conditions favor it. They retain their vitality for a short period only, and therefore function in an immediate reproduction of the species. The branches which produce these spores are called ascending hyphæ or sporophores. Sometimes, asexual spores are formed within the parent cell, and are liberated by the bursting or decay of the cell wall.

Some fungous plants have cells which function as sex organs. They are called the oogonia or egg cells, and the antheridia or sperm cells. When conditions are favorable, the contents of the antheridium fuse with the oogonium, and an egg cell results. These egg cells often retain their vitality during long periods, and serve to carry the disease through a period unsuited for growth of the mycelium.

Sometimes, especially in the case of parasites, special branches are formed which penetrate the host cells and absorb the food material. These special, absorbing branches are called haustoria, meaning absorbers.

164. Mode of life. — In an excellent book on “ Diseases of Plants Induced by Cryptogamic Parasites,” Karl F. Von Tubeuf discusses the mode of life of fungi, as follows:

“ The parasitic fungi may be divided according to the place of their occurrence, and their mode of attack on the host, into two categories, which may be designated epiphytic and endophytic parasites. The former have their vegetative mycelium spread over the surface of the host plant; the latter penetrate into the plant and there develop their mycelium. Both receive nourishment from the cells of the host plant by means of special absorptive regions inserted into the cells of the host, the so-called haustoria.

“ We may distinguish the following groups of parasites according to the degree of their penetration into the organs of the host plant they attack:

(1) *Epiphytes*

- (a) With haustoria which only sink into the outer membranes of the host.
- (b) With haustoria penetrating into the cavity of the host cells.

(2) *Endophytes*

- (a) With a mycelium which grows in the walls of the host cell and is generally nourished without the aid of haustoria.
- (b) With a mycelium which grows in the intercellular spaces only, and is nourished with or without haustoria.
- (c) With a mycelium which penetrates into the host cell and becomes an intercellular mycelium.
- (d) Lower fungi which live completely within the host cell.”

165. Effect on host plant. — It should be understood that fungi do not always destroy plant tissue. Their presence often excites the protoplasmic contents of the plant into abnormal activity, and rapid cell division occurs. This produces various malformations and enlargements in stem area. In other cases, the fungi exert an opposite effect; cell growth becomes checked, and the plant is dwarfed and stunted. The presence of fungous plants may cause unusual development of the flower parts, the petals and other floral organs becoming variously modified. Changes in coloration of flower petals and foliage of plants are often induced because of the presence of foreign plants. The parasite may not kill the protoplasm of the host cell, but it may so affect the chlorophyll bodies in the cell sap that they are broken down, and the tissue of the leaf becomes somewhat colorless.

In a larger part of the so-called diseases of plants the mycelium of the parasite penetrates the vital part of the plant, absorbing the cell wall and cell contents of the host. As a result, the plant becomes weakened, or the complete destruction of the structural tissue will result in the death of the plant. Fungi affect plant tissue in the following ways:

- (1) Killing of host cells by:
 - (a) absorption of living cell contents.
 - (b) absorption of cells or tissues.
 - (c) killing of host cells and tissues by excretion of ferments.
- (2) Killing of organs or whole plants.
- (3) Shortening of life
- (4) Premature development of buds
- (5) Preservation of the host plant, and of host tissue.

166. Character of infection. — In attempting to discover the best methods of preventing attacks of parasites on plants, the investigator must determine how the

fungus becomes established in the plant's system. Occasionally, the fungus is a secondary agent in destroying plant tissue. Insect attacks may be the primary cause, and the fungus gains entrance to the vital part of the plant through injuries caused by these agents. Various forms of plant diseases often follow attacks of aphids. These insects penetrate the epidermal tissue and expose the delicate substratum. Injuries also occur to plant tissue through mechanical means or in handling the plants, and as a result, disease may occur. It is a well-known fact that when a limb is cut from a tree, the spores of various wood-destroying fungi gain entrance to the tissue of the tree, through the exposed surface. Unless some antiseptic material is used to prevent germination of the spores, their development and growth are very rapid. When the epidermal formation is normal, fungi less frequently gain an entrance to the plant.

167. Methods of combating parasitic fungi.—The following methods are suggested by Tubeuf:¹

A. Methods for extermination and removal of parasitic fungi alone.

- (1) Killing of fungi attached to seed, through sterilization by means of hot water or copper steep mixtures.
- (2) Combating leaf-frequenting fungi by dusting or spraying with mixtures containing sulphur or copper.
- (3) Excision and extermination of the sporophores of *Polyporeæ* and *Agaricineæ* on orchard or garden trees.
- (4) Removal and destruction of dead parts of plants carrying sporocarps or other hibernating stages of any fungus

B. Methods for combating fungi by removal of diseased plants or plant organs.

- (1) Removal of the parts of a host plant harboring fungi.
- (2) Removal of the whole or part of a complementary host

¹ "Diseases of Plants Induced by Cryptogamic Parasites," Tubeuf and Smith.

of a heterœcious fungus for the purpose of saving the other host or hosts.

C. The avoidance or removal of conditions which favor infection.

- (1) Preventive measures against wound infection; antiseptic and aseptic wound treatment.
- (2) Avoidance of localities favorable to disease.
- (3) Avoidance of the massing together of plants of the same species and like age; rotation of crops on the same cultivated area.
- (4) Avoidance of neighborhood of those plants which are hosts of the same heterœcious fungus."

CLASSIFICATION OF PLANTS CAUSING DISEASE

Various methods of classification of disease-forming plants have been suggested by students of mycology. The following classification, given by Tubeuf and Smith, seems best suited for a general consideration such as this:

- A. Myxomycetes — Slime fungi.
- B. Schizomycetes — Bacteria.
- C. Phycomycetes — Lower fungi.
- D. Mycomycetes — Higher fungi.

The larger number of diseases are included in Phycomycetes and Mycomycetes.

Phycomycetes include the families Chytridiaceæ, Zygomycetes and Oomycetes; Mycomycetes includes Ascomycetes, Ustilagineæ, Uredineæ and Basidiomycetes. Tubeuf includes also another division of the Mycomycetes, which he calls Fungi Imperfecti. Under Fungi Imperfecti are placed those diseases which have not been completely investigated, most of them being known only in the form of pycnidia and conidia. The number of species included in this group was much larger, but it has gradually been reduced as the forms proved to be stages in the life of some species of definite systematic position in the groups C and D. Fungi Imperfecti is classified into the families Sphærospideæ, Melanconieæ and Hyphomycetes.

STUDY OF DISEASE-PRODUCING PLANTS IN THE
DIFFERENT GROUPS

To understand better the general character of fungi which cause plant diseases, their methods of attack, also methods of prevention and extermination, a general consideration of the more important disease-forming plants follows.

168. Myxomycetes (slime-fungi) — There are few disease-forming agents in the Myxomycetes. They attack root tissue, forming a malformation, and therefore an abnormal growth.

169. Schizomycetes (Bacteria):

(1) Stigmonose of carnations: Stigmonose of carnations is now believed to be a disease which originates where fumigation has been neglected. The soft, succulent tissues of carnations are punctured by insects, and bacterial colonies gain entrance through these injuries. A breaking down of the leaf or stem tissues results. Keeping plants free from insects, and having atmospheric and soil conditions conducive to healthy growth, will assist greatly in keeping this disease in check.

(2) Bacterial difficulties in bulbs Many bulbous plants, such as lilies, hyacinths and tulips, are frequently attacked by bacteria. Frequently, bulbs are harvested before they are mature, and become more or less bruised in shipping. Therefore, the bulbs are more susceptible to bacterial attacks. Care should be taken in buying bulbs, to secure only those with healthy, well-ripened tissue, and which show no indication of the presence of disease.

170. Phycomycetes (Algal fungi). — “Damping-off” fungus. *Classification* · Phycomycetes, Pythiaceæ. *Pythium deBaryanum*. The “damping-off” fungus is the chief representative of the Phycomycetes which is of interest to the growers of ornamental plants. It is common in seed beds and cutting benches and causes a rapid loss of seedlings and cuttings. It attacks plants near the ground, and they quickly fall, the top remaining green for some time after the stem has blackened. Investigation shows the root to be badly decayed before the top reveals the effects of the disease, the moist atmosphere giving the top sufficient moisture to sustain life. The progress of the disease is rapid if the atmospheric conditions are in its favor, and a whole seed-pan may become diseased in a single night. The fungus naturally lives as a parasite on living plants, but it may exist on decaying vegetable matter and then becomes saprophytic.

171. Microscopical nature of "damping-off" fungus. — The vegetative or feeding portion of the fungus spreads through the tissue of the leaf or stem in slender, colorless, mycelial threads which branch in a complex manner. The threads pass between the cells and frequently penetrate the cell wall. This they accomplish by means of a ferment which they are supposed to excrete, and increasing rapidly in size, they absorb the cell contents, until the tissue dies. They have never been found to possess haustoria or true parasitic roots.

172. Asexual reproduction. — After the vegetative mycelium has ramified through the cells of the host-plant, ascending hyphal branches may produce chains of conidia. These conidia are of various forms. They may germinate at once by thrusting out a slender tube through the cell wall, which elongates into a mycelial strand exactly like the mycelium from which it was produced. Some conidia exhibit a resting period and may be distinguished by thicker walls. Sporangia may also be produced from the mycelium, and in form and size resemble the conidia. Their method of germination differs, however. De Bary describes it as follows: "The gelatinously thickened wall at its apex suddenly expands into a thin-walled spherical vesicle, and into this at the same moment the whole of the protoplasm of the cell, which is hitherto undivided, or has shown only transitory beginnings of division, streams rapidly, within a few moments of time at most; there it breaks up at once into a number of swarm-spores (zoospores), which issue from the delicate swelling vesicle and finally germinate."

The swarm-spores have two cilia and by means of these they swim rapidly about in the drops of water surrounding the soil particles, and spread the pathogen with great rapidity. Eventually, they lose their motive power, and develop into the infecting mycelium.

Atkinson states² that in this species, the swarm-spore stage (zoospore) is not so abundant as the oogonia, or egg stage.

173. Sexual reproduction. — A microscopical examination of the tissue of seedlings which have been killed by this fungus shows rounded or spherical bodies, from three to five times thicker than the mycelial threads. They are the oogonia, or eggs, of the sexual stage of reproduction. They may be at the terminal of the mycelial strand, or at the end of short branches of the mycelium, or they may occur as enlargements, with no reference to the end of the strand.

¹ "Fungi Mycetozaa and Bacteria," p. 137.

² "Damping Off," Bulletin 34, Cornell Experiment Station.

From a small enlargement, the oogonium develops into a thick-walled, colorless body, which is shut off from the mycelial strand by partition walls. A rounded mass of granular protoplasm separates from the cell wall, and forms a more or less solid body in the center. This is surrounded by a clear fluid called the periplasm. Thus the egg or female organ becomes ready for fecundation.

A stalked antheridium is formed from a section of the same mycelial thread which bears the oogonium, by a partition wall cutting off an elongated cell. This is the male cell. One end comes in contact with the wall of the oogonium; the whole cell swells, and the end thus in contact puts out a slender tube which pierces the oogonium, extends through the periplasm, and discharges its contents or sperms into the oogonium contents. This fecundated cell now becomes the egg, and in this stage, the fungus may rest for a considerable time. The oogonium is always formed within the cell structure of the host, and is only liberated by decay of the stem, and the rupture of the wall of the oospore.

174. Ecology of "damping-off" disease. — Some of the conditions favoring the development of the pathogen are a close, humid atmosphere about the seedlings or cuttings; over-watering of plants, especially at night; seedlings weakened because of insufficient air, food or light; the seed-pan insufficiently filled with soil to bring seedlings high enough for perfect ventilation about the base of the stems, and seedlings too thickly planted.

175. Preventives. — The "damping-off" fungus may in a measure be prevented by sterilizing the soil for a few hours before sowing seeds or transplanting seedlings; using fresh sand in cutting benches; using plenty of sand in soil to insure perfect drainage; giving seedlings plenty of light and ventilation to insure a strong, vigorous growth. Apply water in the morning, and do not over-water.

176. Remedies. — To assist in overcoming the fungus, stir the surface soil and keep the temperature low. If plants are large enough, transplant at once into soil which is free from spores. Sprinkling with warm sand may serve to check the spread of the fungus.

177. Mycomycetes. — This great group comprises the Ascomycetes (*Sac fungi*), which are the principal fungi attacking greenhouse plants; also the Uredineae, Basidiomycetes and what are called *Fungi Imperfecti* (those in which some of the stages are unknown).

178. Rose mildew. — *Classification:* Perisporiaceæ. *Sphæro-*

theca pannosa. The rose mildew is exceedingly troublesome on both outdoor and indoor roses, and frequently causes an immense financial loss to commercial growers. To amateurs it is a discouraging element in the culture of outdoor roses. It attacks the younger leaves, and forms small, white patches. Soon it spreads over the entire leaf surface. Young leaves and buds when attacked become deformed, their function is interfered with and death may result. Often the foliage of an entire crop is quickly injured by an attack of this fungus, and the plants become defoliated.

179. Microscopical nature of rose mildew. — The vegetative or feeding portion of the fungus spreads over the exterior surface of the leaf. If a spore falls on the moist surface of the leaf, it quickly germinates and a mycelial thread develops. This thread attaches itself to the epidermal cells by means of haustoria and absorbs the cell contents. The mycelium becomes much branched and in a short time completely covers the surface of the leaf. It may also extend over the younger growth of the stem and cover the bud.

180. Asexual reproduction. — When rose plants are growing rapidly and conditions favor rapid mycelial development, the mycelium spreads over the leaf for a short time. Ascending branches are then formed, and from the tips of these, asexual spores of conidia are produced in great numbers. When mature, they separate from the conidiophores or stalks on which they are produced. They are carried by the lightest breeze, and if they fall on young rose tissue, they germinate immediately and rapidly produce new plants. This is the usual and most rapid method of reproduction.

181. The resting stage. — When conditions are unfavorable for the rapid growth of either rose leaves or mycelium, thick-celled and usually dark-colored bodies form on the mycelial strands. They are ascocarps which contain the resting spores of the fungus. Within these thick-walled bodies there are numerous, club-shaped spore-cases placed together in a crowded manner, and within each of these spore-cases several spores are formed. These are the ascospores which, when liberated from the ascocarp, reproduce the fungus. These reproductive bodies or ascospores are formed by nuclear divisions inside the club-shaped cells which are called asci. Because of this manner of reproduction, the mildew exists through a long period if conditions are unfavorable for growth.

182. Ecology of disease. — A frequent cause of mildew is a lack of ventilation in rose houses. This, with too high a tem-

perature, will stimulate a soft, succulent growth which is very susceptible to the pathogen. Damp atmospheric conditions, especially at night, sudden changes in temperature, lack of drainage and improper feeding, cause the disease in greenhouses; while inferior air circulation over the beds, such as is caused by nearby evergreen trees or other shade, and imperfect drainage, favor mildew outdoors.

183. Preventives. — To prevent mildew, grow the plants indoors in large houses, where rapid changes of temperature and drafts can be avoided. Give plenty of ventilation when the plants are first started, to insure a firm, vigorous growth; keep a little heat in the greenhouses during the nights of late spring and early fall, and keep the ventilators open at the same time, so there will not be an accumulation of moisture in the houses. Remove all dead leaves, especially during the season when rose plants are resting.

184. Remedies. — A remedy for mildew is the frequent dusting of the foliage with powdered sulfur. Indoors, a sulfur wash is applied to the heating pipes, and the fumes are destructive to the parasite.

185. Violet stem-rot. — *Classification.* Ascomycetes, Perisporiaceæ, *Thielavia basicola* Zopf. Violet stem-rot is a very common and serious trouble for violet-growers. It first attacks the stems of violet plants, and later may attack the roots. Plants, even when affected with the disease, may make good growth throughout the summer, but after being placed in the house they will wilt for a short time each day, reviving at night. This may occur for a week or more, when they will wilt completely and die. As the fungus acts slowly at first, the disease may not become apparent for a considerable time after the plants are in the houses.

186. Microscopical nature. — The mycelium first attacks the epidermal cells, and bores through the cell walls. Later it attacks the underlying tissue.

187. Reproduction — Tubeuf¹ describes the reproduction of violet stem-rot as follows: "Three kinds of reproductive organs are produced on the underground parts of the plants: (1) Cylindrical, delicate, hyaline chlamydospores produced in pistol-shaped branches of the mycelium. (2) Thick-walled, brown-coated, resting conidia arranged several in a row, like spores of *Phragmidium*. (3) Perithecia or little, spherical, permanently closed,

¹"Diseases of Plants Induced by Cryptogamic Parasites," Tubeuf and Smith, p. 182.

brown structures with ovoid asci containing eight brownish, lemon-shaped spores.

"A white coating of the hyaline conidia is first formed, then a brown coating of the dark conidia, and finally perithecia."

188. Ecology of disease — The causes of violet stem-rot are a weakening of parent plants through improper cultural conditions, and their constant propagation by division. This propagation takes place after a season of flowering when the parent is materially weakened by the forcing process.

189 Preventives. — Always examine carefully all plants before propagating, making certain that the disease is not present. Use clean sand for all cuttings, as this fungus, and several others closely related, may live in a saprophytic manner on decaying vegetable matter. Keep the temperature of the violet house low, and stimulate strong, healthy tissue.

190. Remedies — There are no remedies. Plants should be carefully examined before being planted in the houses, and if the disease is present, they should be discarded at once.

191. Uredineæ (Rust fungi) — The principal fungi attacking greenhouse plants in the Uredineæ, are carnation rust and rose rust.

192 Carnation rust. — *Classification.* Uredineæ. *Uromyces caryophyllinus* Schrank. The first announcement of the European importation of this pathogen was made by J. C. Arthur in the *Botanical Gazette*, November, 1891. For several years it caused great apprehension among carnation-growers because of its rapid spread throughout American carnation ranges. Many remedial measures were tried without success. The rust attacks carnations in all stages of growth. The disease is first revealed by light green spots on the epidermis. These quickly assume a dark, red-brown color. In due time the epidermis ruptures and the spores escape in masses of a rust color, giving the disease its common name.

Within recent years, improved cultural conditions and the introduction, through breeding, of rust-resistant varieties, have resulted in an appreciable decrease in the amount of rust present in carnation houses.

193. Microscopical nature and reproduction. — The mycelium extends through the intercellular spaces of the leaves, and forms patches of spore-bearing areas beneath the epidermis. The epidermis ruptures, and uredospores are first produced. These usually germinate at once, forming new, infecting mycelia. Later, teleutospores are produced, and constitute the resting stage of the pathogen.

194. Ecology of the carnation rust disease. — Faulty ventilation which produces close, humid conditions, and any cultural treatment which induces a soft, succulent growth, favor the development of the parasite

195. Preventives. — Propagate only firm, strong, disease-resistant stock, such as present-day breeders are now producing. Give careful attention to all cultural details, especially ventilation. Syringe the plants only on bright, sunny days. Fungicides are sometimes used as preventives. They assist in keeping the plants healthy, but these should be of such a character that they do not make the foliage unsightly. Bordeaux mixture will do this. Before the cuttings are potted, they may be sprayed with a solution of copper sulfate, using a fine spray to cover both sides of the leaf. After the plants are established in thumb pots, it is well to spray a second time.

196. Remedies. — There are no remedies, so far as known, for carnation rust. If plants are infected, they should be removed and burned. The benches should be thoroughly white-washed and fresh soil used.

197. The rose rust. — *Classification*: Uredineæ, *Phragmidium subcorticium* Schrank; and *speciosum* Fr. Of the two species of rose rust, *Phragmidium subcorticium* is the most common. It is rarely found on roses under glass, but confines its attacks principally to the leaves of hybrid perpetuals and other outdoor species. *Phragmidium speciosum* usually attacks the stems.

198. Microscopical nature of rose rust — Its microscopical nature is not unlike that of the carnation rust. All forms of spores, however, are produced by these species.

199. Ecology of disease. — The vigor of rose plants weakened by imperfect drainage, or other soil conditions, may be responsible for this disease.

200. Preventives. — Occasional sprayings with Bordeaux mixture or ammoniacal carbonate of copper assist in preventing rose rust. It is well to spray early in the season before the disease becomes established. *Phragmidium speciosum* rarely appears until late in the season. If the disease is present, all tissue should be removed and burned. Leaves from the rose bed should be gathered in the fall and burned, to destroy the teleutospores.

There are no known remedies for the rose rust.

201. Basidiomycetes. — In Basidiomycetes, the spore-bearing cells are called basidia. These are of definite shape and have lateral branches, called the sterigmata. From these, a definite number of basidiospores are abjoined, the basidia then becom-

ing functionless. In the development, two nuclei have been found to copulate in the basidial cells. The nuclei then divide and produce two or four new nuclei. A nucleus then passes through the sterigmata into the developing basidiospore. The most important disease-forming agent in Basidiomycetes is the wet rot of carnations.

202. Wet stem-rot of carnations.—*Classification.* Basidiomycetes, *Hypochneæ*, *Rhizoctonia* (species) (*Corticium vagum*, var. *Solan*). The wet stem-rot of carnations is one of the most troublesome diseases with which the grower deals. The fungus usually attacks the stem of the plant near the ground, and carnation plants which are so placed that they branch a little above the ground are less liable to attacks. A branch of a plant will rot off, and others soon follow. Affected plants first assume a light, yellow color, the foliage of a branch wilts and later the plant dies.

203. Microscopical nature and reproduction.—The mycelium lives on the roots of many plants, especially weeds, and it has been demonstrated that the same fungus may attack a wide range of species. This same mycelium may run over the surface of the leaves. The whole finally forms thread-like strands of vegetative mycelium. As these mycelial strands are torn apart, they have the power of reproducing new, vegetative tissue and the fungus rapidly spreads in this way. Resting structures are formed as black, tuber-like bodies on the cortical tissue of the stem. These serve to carry the pathogen over from one year to the next. No asexual spores are formed. Basidiospores are often produced on a white, webby mycelium on the stems of plants just above the surface of the soil.

204. Ecology of the disease.—Injury to the stem near the ground, which may result from heavy winds sweeping over the fields, may cause carnation plants to be affected with stem-rot. If branches split partially, near the ground, the fungus may gain entrance to the tissue.

205. Preventives.—To prevent stem-rot, encourage the branching of the stem a little above the ground. Do not set the rooted cutting deeply in the soil. Place the plant in the soil no more deeply out of doors than it was in the pot. Special care should be taken in bringing the plant into the house in the fall. This is naturally a great check to the growth of the plant, which is materially weakened thereby. If the plant is set deeply in the soil and watered too generously, stem-rot is very likely to occur.

206. Remedies.—As soon as the disease is discovered in the

house, remove at once the affected plants, and a considerable amount of soil in their immediate vicinity. Strong, vigorous plants should be selected to replace diseased ones. If they have a well-developed, central stem, which brings the crown well above the soil, plants are less susceptible to stem-rot.

207. Fungi Imperfecti. — Tubeuf classifies under Fungi Imperfecti all other species of fungi common on cultivated flower crops. Among the diseases included in this group are the leaf-spots on violets, carnations, and chrysanthemums, violet anthracnose, mignonette disease and the branch-rot of carnations.

208. Leaf-spot on violets. — *Classification:* Sphærioidæ; *Phyllosticta violæ* Desm. *Phyllosticta* on violets is of considerable importance and should be carefully kept in check. *Phyllosticta* infests certain cells, then spreads to adjacent cells, causing a discoloring of the area attacked. The withered tissue falls out, and this is what gives the disease the characteristic name of "shot-hole fungus." Innumerable, colorless conidia form in the affected areas.

209. Preventives. — Keep the plants free from all leaves affected with leaf-spot to prevent the spread of the disease.

210. Black-spot on roses. — *Classification:* Sphærioidæ; *Actinonema rosæ* Lib. Black-spot is frequently found in green-houses where roses are grown, and in outdoor rose gardens. The disease first appears on the foliage, as a dark-brown spot with an irregular margin. This spot increases in size, and the leaf area surrounding it assumes a pale yellow color and soon defoliation occurs.

211. Microscopical nature. — The mycelium is distributed both inside and outside the leaf tissue. The action of the mycelium on the cell contents renders the protoplasm dark-colored and granular. This gives the leaf the characteristic spot. The yellowing of the surrounding tissue is also caused by the action of the mycelium.

212. Reproduction of black-spot. — On the mycelium in the darkened areas, numerous pycnidia are formed, and from these two-celled conidia are developed. These bring about the rapid spread of the pathogen. When the spores fall on the moist surface of a rose leaf, they quickly germinate and produce a new infecting mycelium.

213. Ecology of the disease. — Imperfect drainage is often responsible for a weakened growth of the rose plants, and this favors the development of the disease. Carelessness in watering, a sudden drop in the temperature of the rose house, and imperfect circulation about the plants, seem to cause a similar result.

214. Preventives. — Careful attention to watering and ventilation will, in a measure, prevent an attack of black-spot. Its presence outdoors usually indicates imperfect soil drainage. Black-spot is more prevalent on roses grown in heavier soils than on those grown in light soils. The temperature of the rose house should never drop below that required for the varieties grown. The house should be kept entirely free of all diseased leaves.

215. Remedies. — As soon as the disease becomes apparent, pick off affected leaves and spray the plants with ammoniacal copper carbonate.

216. Leaf-spot on carnations. — *Classification:* Sphærioidæ; *Septoria dianthi* Desm. Leaf-spot on carnations is very prevalent. It forms circular spots in the center of the leaves, or irregular blotches on the margin, and it may attack the stems. The center of the spot is gray-brown, while the margins have a purplish tint. The leaf becomes deformed as its tissue shrinks, and in a short time it turns yellow and dies.

217. Microscopical nature. — The mycelium enters the leaf tissue through the stomata, spreads throughout the intercellular spaces, absorbs the cell contents, and causes the characteristic spotting.

218. Reproduction. — In a short time, pycnidia form in the lighter portions of the spot. Pycnidia are black, flask-shaped bodies, and contain numberless, many-celled spores. In their development, they rupture the epidermal cells and are liberated. They are carried by air currents or by water in syringing, to moist, healthy tissue, where they germinate quickly and inoculate other leaves.

219 Ecology of leaf-spot. — A close, humid atmosphere, and too much water at the roots, are causes of leaf-spot.

220. Preventives. — To prevent leaf-spot give careful attention to temperature and atmospheric conditions in greenhouses, and avoid over-watering.

221. Remedies. — The writer's attention was recently called to a bed in which leaf-spot had gained a decided foothold. The affected tissue was removed and burned; careful attention was given to watering; the temperature was kept comparatively low, and the plants were sprayed with ammoniacal copper carbonate. The bed soon began to show a marked improvement, and within two months the disease had entirely disappeared.

222. Leaf-spot on chrysanthemums. — *Classification:* Sphærioidæ, *Septoria chrysanthemi* Allesch. Leaf-spot on chrysanthemums is quite general, and during seasons when the temperature

runs high in the late fall, it causes considerable damage. The microscopical character and reproduction are similar to the leaf-spot of the carnation, as are also the preventives and remedies.

223. Anthracnose of the rose — *Classification* Excipulacæ; *Glæosporium rosæ* Hals. Anthracnose occurs to a limited extent on outdoor roses, usually attacking the canes, although it may appear on the leaves. It reveals itself in red-purple spots. It rarely attacks indoor varieties.

224. Microscopical nature and reproduction — The mycelium ramifies through the tissue of the stems and leaves, and feeds principally in the cells of the cambium layer of the stem, causing a breaking down of the tissue, and a consequent girdling of the stem. It produces conidia which are one-celled and colorless. They germinate easily and the disease spreads rapidly.

225. Preventives and remedies. — To prevent or remedy anthracnose, give the plants thorough drainage, also sufficient food to enable them to grow vigorously. Cut out all affected tissue, and spray the bushes with Bordeaux mixture or copper-carbonate solution.

226. Violet anthracnose. — *Classification* Excipulacæ; *Glæosporium violæ* B. & Br. Anthracnose attacks violet leaves, but causes little trouble on plants otherwise healthy. The fungus spreads from the margin of the leaves over the entire surface, the tissue becoming brown and shriveled. Reproductive bodies form in patches on the mycelium underneath the epidermis, and as they mature, the epidermis ruptures and the spores escape.

The only preventive is to keep the diseased tissue picked from the plants.

227. Mignonette disease. — *Classification* Hyphomycetes; Dematiæ, *Cercospora resedæ* Fuck. Mignonette disease is a fungus which is very common. It shows itself by small depressions of the leaf with brown or yellow borders. Gradually the fungus affects the whole tissue of the leaves and they wither.

228. Microscopic character and reproduction. — The mycelium spreads throughout the tissue of the leaf and sends out spore-bearing tufts through the stomata. Spores are produced in great numbers.

229. Preventives. — Keeping the diseased tissue cut off, and spraying occasionally with copper-carbonate solutions, will hold the disease in check.

230. Other diseases of similar character are caused by: *Cercospora violæ* Sacc. on the violets; *Cercospora rosicola* Pass. on the rose; *Cercospora althæna* Sacc. on the hollyhock.

231. Fairy-ring spot on carnations — *Classification.* Hyphomycetes, Dematiæ; *Heterosporium echinulatum* Berk. Fairy-ring spot on carnations is quite prevalent in some sections, the disease attacking the leaves, stems and sepals of the flower. Light-colored spots appear on affected tissue and on these are formed concentric rings of dark-colored, spore-bearing bodies. The spores are usually four-celled and from each cell an infecting germ-tube develops. A second row of spore-bearing bodies develops in a concentric ring around the first, and this continues indefinitely, giving to the fungus the common name of fairy-ring.

232. Branch-rot of carnations — *Classification.* Tuberculariæ; *Fusarium*, species. Branch-rot is frequent on carnations, attacking the larger branches and sometimes the main stem. When the disease gains a foothold, the stems gradually wilt and the foliage turns a yellow green. The stem tissue becomes dry and firm, even after the death of the plant has resulted. It may attack the host at any time, and is frequent in the cutting bench.

233. Microscopical nature — The spindle-shaped and sickle-like spores of this fungus are produced in quantities on the mycelium of the plant. When they fall on plant tissue where the epidermis is injured, they quickly germinate. An infecting mycelium penetrates the interior tissue of the stem, and absorbs the protoplasmic cell contents. This causes the tissue to become shrunken, the vital processes of the plant are checked and starvation results.

234. Preventives. — As branch-rot commonly attacks cuttings, conditions in the propagating house should be such that the development of the disease will be checked. It is considered wise to avoid shortening the terminal growth when cuttings are made, for this injury to the leaf tissue permits the pathogen to gain an entrance to the interior of the stem. Sand in the cutting benches should be changed frequently and everything possible done to encourage a rapid rooting and a healthy development of the cutting. Take cuttings only from healthy stock, and use great care in re-potting and in field planting. This assists in keeping the plants free from branch-rot.

235. Remedies. — So far as known, there are no remedies. If the disease gains a foothold in the benches, all affected plants should be removed and replaced by healthy, disease-resisting varieties.

CHAPTER XII

INSECTS ON GREENHOUSE PLANTS

MUCH has been published regarding insects which prey on greenhouse plants, yet much remains to be learned of their life history and the best methods for their extermination. Prevention of attack, rather than attempting to destroy established pests, is to be preferred. Correct environmental conditions stimulate a strong, vigorous growth in plants, which is the first essential for keeping in check attacks of insects.

The yearly damage by insects in greenhouses is enormous. In many cases it is due largely to a lack of knowledge regarding the character of the attack and of methods for combating it. As the plant-growing industry has increased, resulting in frequent interchange of plants and cuttings among growers in America and those of other countries, there has been a corresponding increase in the numbers and species of insects attacking cultivated plants. To understand the best methods of combating insects, a knowledge of their general character is necessary. Such knowledge reveals the weak points in their reproduction, growth and development, and suggests methods of extermination.

236. Structure. — All insects in their adult or perfect stage are characterized by having three pairs of legs, and usually one or two pairs of wings. Their external skeleton is variously segmented into joints or rings. They are

grouped in three divisions: the head, which contains the organs of vision, the antennæ or feelers, and the mouth parts; the thorax, containing the organs of locomotion, the legs and wings; and the abdomen, containing the organs of digestion, respiration and reproduction. Careful examination of each segment of the abdomen shows breathing holes, or spiracles, which connect with air tubes extending to all parts of the body.

237. Metamorphoses. — Many insects in the course of their development pass through four distinct stages of existence. The first is the egg; the second the larval; the third the pupal; and the fourth the mature or adult insect. Attacks made on certain species of insects are the most successful while still in the egg stage. In other species, the pests are exterminated most easily in the larval stages, while in still others, the adult stage is the most opportune time for extermination. Many florists have no knowledge of the changes which insects undergo. These changes are usually spoken of as metamorphoses. Insects which pass through all stages of development are said to have complete metamorphoses. In some insects the changes are less pronounced, and such are said to have incomplete metamorphoses.

In the larval stage, many insects are voracious feeders, and then it is that much damage is done to florists' crops. The larvæ are generally known as worms, grubs, borers or maggots. The most active insects become more or less dormant in a later stage, and often weave a web, or cocoon, about themselves, passing into a stage of apparent rest. Marvelous transformations are, however, going on beneath the cocoon covering, and in due time the complete, or perfect insect emerges in a winged form. Some insects pass the entire winter in the cocoon stage. The

life of a mature insect is usually short. Frequently they eat but little, and exist only long enough to fulfill their mission of laying eggs, or providing in other ways for the reproduction of the species. The few insects which pass the winter in the adult stage usually bury themselves underneath rubbish or in soil, and remain dormant. Some outdoor insects pass the winter in the egg, and if they can be discovered and destroyed in this stage, large numbers of the young will perish. Many hibernate in cocoons.

238. Reproduction. — Some insects give birth to living young, while others reproduce by eggs. The larger part come in the last group.

239. Classification by feeding habits. — There are various ways of classifying insects, but for the purposes of extermination, the classification most effective is that which refers to the manner of taking food. They are classed as biting or chewing insects, and as sucking insects.

A careful study of the mouth parts shows that chewing insects have an upper and a lower lip. They also have two pairs of jaws moving sidewise between these lips. These insects have the power of tearing vegetable tissue in pieces, and then swallowing it. In other insects, the mouth parts have been so modified that they seem to have no jaws at all. They have a long, beak-like organ, with certain parts of which they puncture the epidermal tissue of leaves and suck the juices of the plant.

240. Methods of combating insect attacks. — In view of the fact that some insects chew the foliage, while others only puncture the epidermis and suck the juices from the tissue beneath, it is obvious that both classes cannot be treated alike. In many instances, both chewing and

sucking insects have hard, outer body-coverings, which act as a means of defense from contact poisons.

As before noted, insects breathe through minute openings in the segments of the abdomen. Anything which closes these produces suffocation. Certain gases are, therefore, as injurious to insect life as are poisonous gases which enter the lungs of human individuals through the nostrils.

A study of structure and habits reveals the fact that there are four principal methods of combating insects: first, by poisoning with substances taken into the digestive system through the mouth; second, producing death with irritating chemical substances which destroy the skin and the tissues beneath; third, by suffocation through closing the breathing pores of the body; fourth, by poisoning with gases which are taken into the body through the breathing pores.

241. List of pests commonly found in greenhouses. —

(a) *Chewing.*

- (1) Exterminated by hand picking or arsenical poisons.
Leaf Rollers, Archips, various species.
- (2) Exterminated by freezing the soil in winter, or by removing them from the soil.
White Grubs, *Lachnosterma*, various species
- (3) Exterminated by trapping with poisoned bait, or by hand picking.
Cutworms, various genera and species.

(b) *Sucking*

- (1) Exterminated by water sprays and salt solutions.
Red-Spider, *Tetranychus bimaculatus* Harvey.
- (2) Exterminated by tobacco fumes.
Green Aphis { *Myzus persicae* Sulz.
 { *Nectarophora rosae* Linn.
Black Aphis, *Nectarophora chrysanthemicolens*
 Wahl.
- (3) Exterminated by tobacco dust in soil
Blue Aphis, *Aphis middletonii* Thos. (?)

- (4) Exterminated by poisonous fumes or contact mixtures.
- White Fies, *Aleyrodes vaporarum* Westw.
 - Thrips, *Heliothrips hæmorrhoidalis* Bouche
 - White Mealy Bugs, *Orthesia insignis* Dougl.
 - Yellow Mealy Bugs, *Dactylopius destructor* Comst.
- Scale Insects {
- Aspidiotus, various species
 - Diaspis, various species.
 - Chionaspis, various species
 - Lepidosaphes, various species.
 - Lacanium, various species.

242. Method of attack. — It will be observed from the above classification that few greenhouse insects are injured by direct poisons such as Paris green and arsenate of lead. The larger part are killed by contact poisons or by fumes of poisonous gases. Formerly, fumigation by gases was looked upon with suspicion, because of the deadly character of the fumes, but now, with improved methods of control and application, it has come into more general favor. The practice of spraying with poisonous solutions is rarely followed in greenhouse work.

243. Pests exterminated by hand picking or arsenical sprays. — Among the larvæ of insects which cause much injury to flower crops, are various so-called caterpillars. Many of them feed on leguminous crops, such as the sweet peas; some feed on chrysanthemum foliage and others on the rose

Among insects destructive to rose foliage is the oblique-banded leaf-roller, *Archips rosaceana*, which is especially troublesome at times. The leaf-roller causes the greatest amount of damage during the fall and spring. It is of a light cinnamon-brown color, with three broad, oblique, dark brown bands across the wings. The moth deposits the egg masses on the bark, and from these the larvæ hatch. These are light green in color, varying in some specimens to a red- or brown-green. They feed on the foliage, and it is during the larval stage that most of the damage is done. Before pupation, the larva draws the leaves together, thus forming a cocoon. From the pupa, the moth emerges, and the round of the life cycle is complete.

244. Remedial measures. — Experiments in fumigation with hydrocyanic acid gas prove that the larvæ are not seriously injured by this treatment. During the feeding season, the foliage may be sprayed with arsenate of lead, using three pounds of lead to fifty gallons of water. This, however, may spot the foliage, and unless the plants are seriously infested, it would hardly be advisable to use poisons of this sort.

Hand picking of the larvæ, or trapping the moths by placing lanterns in pans of water, seem the most effective remedial measures. For caterpillars on chrysanthemums and sweet peas, hand picking also seems the most practical method of extermination.

245. Pests which may be kept in check by removing them from the soil. White grubs or May-beetles — White grubs are often exceedingly injurious to many crops. They live in the soil and feed on plant roots. The attention of the writer was recently called to a serious attack of this larva on the roots of cyclamen. They also attack the roots of the rose, carnation and other plants which are usually grown in beds or benches. The life history of the white grub has been worked out as follows: the grubs begin to pupate in the ground in June or July. Later, they change to beetles and remain in the ground through the winter. They feed through a second summer, and the following spring they emerge and feed on the leaves of trees, mate, and lay their eggs in the earth in June or July. These soon hatch into grubs, which remain in this stage over winter. These pests, therefore, may pass the winter in the ground in the beetle stage or in the larval stage. The feeding habits of the two vary, however, for the larvæ are the only forms destructive to roots, hence this stage is the one of most interest to the flower-grower.

246. Habitat. — While the larvæ are most common in pasture sod, they may be abundant in sod from mown land, and may also occur in soil which has been under cultivation for some time.

247. Methods of preventing attack. — As the flower-grower makes use of large amounts of fibrous sod, it is very probable that the larvæ of these pests pass the winter in the compost heap. Field preparation of the soil is, therefore, advisable. There is an opinion among growers that late fall plowing destroys this insect. Scientific observations claim that the grub goes downward in late fall, and may reach a depth of two or two and one-half feet. If this is true, the larger part of the larvæ are below the reach of the plow by October. Early in the spring, they come nearer the surface, but the greater part are uninjured by spring plowing or other treatment of the land. However, until further experiments have demonstrated the ineffectiveness of fall plowing for ridding the soil of white grubs, this practice is safe to follow. Swine feed on these larvæ, and are recommended as a means of ridding the soil of the pest.

248. Pests exterminated by poison baits or by hand picking. Cutworms. — There are many forms of cutworms, and they belong to different genera. Of these genera, *Agrotis*, *Hadena*,

Euxoa, *Feltia*, and *Noctua* are most common. Cutworms vary considerably in the details of their life history, but in general, there is a similarity among the different genera and species. The dull brown moths are night flying, and lay their eggs at the base of the plants. They hatch into dull-colored caterpillars, varying in length from one to two inches. As a rule, they feed on succulent vegetable tissue near the ground, but if this is not available, some species will climb the stem, and feed on developing buds or tender foliage. Under glass, cutworms are sometimes destructive to carnations. They feed on the side of the bud, often making a large opening.

249. Remedial measures.—By carefully inspecting the plants after dark with a light, many of the worms may be discovered and destroyed. Since they spend the day in the soil just below the surface, careful watch for them should always be kept when stirring the soil in plant beds. Cutworms are not active, and they will eat attractive food which is on the ground rather than climb plant stems for it. A poisoned bait is, therefore, an excellent method of exterminating them. An ounce of Paris green or white arsenic may be mixed with a pound of bran, adding enough water to make a soft mash, and also sufficient molasses to attract the pests. Snails and slugs may also be trapped in a similar manner.

Cutworms pass the winter in cells which they make for themselves in the soil. If these cells are disturbed by fall plowing, many cutworms will be destroyed. The plowing should, however, be done late enough so that the worms cannot crawl back into the soil before they are killed by the cold.

250. Pests exterminated by water sprays and salt solutions.
The red-spider.—Red-spiders attack a wide range of greenhouse plants. They are nearly microscopic in size, and vary in color from green and yellow when immature, to the bright red of the adult. When mature, the red-spider spins a fine web over the foliage, and under this protection, feeds on the epidermis of the leaf. Here also the eggs are laid, and the young are reared. The presence of red-spiders is indicated by a yellowing of the foliage. An experienced eye rarely mistakes the attacks.

251 Greenhouse conditions which favor growth and reproduction.—Hot, dry atmospheric conditions in the houses favor development of the red-spider so that when plants are first placed in the houses, care should be taken to syringe them frequently and to moisten the walks to keep the pests from gaining a foothold. Once established, they are difficult to exterminate, and even a damp atmosphere has little effect on them.

Carnation plants in benches along the sides of the houses are especially liable to be attacked by red-spiders. It is difficult to syringe the back rows of plants, and the warm, dry, atmospheric conditions near the glass favor their development. It is always advisable to place the benches away from the side-walls.

252 Effects of fumigation with hydrocyanic acid gas.—Fumigation with hydrocyanic acid gas seems to have no effect on red-spiders. After an all-night application of this fumigant in sufficiently strong proportions to kill all plant life in the houses, they have been found as lively as ever, when examined under a microscope.

253. Effects of water sprays and salt solutions—Water, thoroughly syringed over both surfaces of the leaf, seems the best remedy. Recently, a salt solution has come into quite general use for red-spiders on carnation plants. C. W. Ward,¹ in his book on the carnation, says, "During the past three years we have been using a solution of salt made as follows: Eight six-inch pottfuls of common salt, dissolved in fifty gallons of water. When using this solution, always stir the bottom of the barrel in order to insure an even strength throughout. Give the foliage a thorough spraying both underneath and above, using a fine hose, with water under considerable pressure. After syringing with the salt solution, this should be allowed to remain from three to four days in bright weather, and from one to two days in dark, cloudy weather, after which the salt should be thoroughly washed off the plants by a strong syringing with clear water. Care must be taken not to syringe with the salt solution too often. The carnation plant loves a certain amount of salt, and is not injured by what will reach the soil, provided the applications are not too frequent or the solution too strong.

"Do not spray the plants with the salt solution unless the foliage is in a firm, well-hardened condition, for if applied to plants that are in a soft state, — that is to say, those which have been grown under too high a temperature or in soil that has been kept too moist, — the tender foliage will be injured or burned, and as the salt keeps the foliage constantly wet during the night, there is some danger of developing spot upon very soft plants.

"An application of salt should generally be made no oftener than once in two weeks; however, we occasionally syringe with the salt mixture upon alternate days, using the weaker solution of salt. The red-spider does not thrive upon the carnation

¹ "The American Carnation," by C. W. Ward.

foliage when it is coated with the salt crystals; and after one or two thorough applications of the solution, comparatively few of the insects will be found."

254. Effects of sulfur. — Fumes of sulfur succeed in keeping the red-spider in check, but destroy only a few. About one-quarter of a pint of sulfur is mixed thoroughly with one quart of boiled linseed oil, and this mixture is painted on the pipes.

255. Pests exterminated by tobacco fumes — Different forms of tobacco preparations are used to keep the sucking insects in check. These preparations are especially effective with the various forms of aphids,* but less so with scale insects, white fly and thrips. They cause suffocation by closing the breathing pores of insects.

256. Tobacco products most used. — In the earlier days of fumigation, tobacco stems and other waste tobacco products were generally used. They were usually burned, filling the house with smoke. They were effective in their destruction of many insects, but left disagreeable odors in the houses, and more especially were they detrimental to the fragrance of many flowers. Recently, various extracts of tobacco have come into popular favor, among these being "Aphicide," "40 per cent Nicotine," "Nicotiana," "Aphiné," "Nicoticide" and "Nicofume." These preparations are considered by many to be expensive, but their effective destruction of insects, and the small quantity necessary, bring them within the means of most florists. These extracts rarely leave disagreeable odors on the flowers.

257. Pests exterminated by tobacco dust in the soil. — Asters are frequently attacked by a blue aphid which sucks the juices from the roots. If a small handful of tobacco dust be placed about the roots of the plants when they are set in the field, these insects will be kept in check.

258. Pests exterminated by poisonous fumes. — Most greenhouse pests may be destroyed by fumigation with hydrocyanic acid gas. As the nature of this is now better understood, it is coming into general use. White flies, mealy bugs, and soft and hard scale insects are among those killed by this treatment.

259. Effects of gases on insect and plant life. — Insects must breathe, and so long as gases penetrate everywhere, the solution of the problem of insect extermination by poisonous gases seems to lie in the use of such gases. Unfortunately, these gases may also be injurious to plant life. The problem of the fumigator, therefore, is to liberate sufficient poisonous gas in a house to kill all insects without injuring the plants.

To determine the correct amount, requires careful study and

experimentation. Different strengths also have their effects in destroying the protoplasmic content of the plant. Still another problem which confronts the flower-grower is to determine the proper time of day for liberating this gas, for it is known that plants are more susceptible to injury when the vital processes of the plant are most active. Experimentation proves that early evening is the best time for this work. The gases are allowed to remain in the houses overnight.

260. The use of hydrocyanic acid gas as a fumigant. — Hydrocyanic acid gas is now quite generally used for the destruction of white flies, thrips and other insects difficult to exterminate with tobacco fumes. Care must be taken to use proper amounts of this gas, for if large amounts be liberated, the plants may be seriously injured. The amount most generally used is one ounce of potassium cyanide for every thousand cubic feet of greenhouse space. A special formula for houses in which such tender plants as coleus, antirrhinum and adiantums are grown, is one ounce of potassium cyanide to two thousand cubic feet of greenhouse space. With this amount of cyanide, one ounce by measure of sulfuric acid and three ounces by measure of water, should be used. This should be prepared as recommended by Fernald. Light fumigations once in from four to seven days are preferable to heavy fumigations.

In a paper on fumigation¹ prepared by H. T. Fernald of Massachusetts Agricultural College, Amherst, Massachusetts, he says, "Hydrocyanic acid gas is perhaps the most poisonous gas known — at least, at all well known. It can be produced from various chemicals, but until recently it has generally been obtained by adding sulphuric acid to potassium cyanide. It has been used experimentally, and by comparing results a general rule for its production and application has been outlined and published, which has come into quite general use for greenhouse work. Strangely enough, however, just what amounts of the various materials should be taken, and the best grade of these for the purpose, have only recently been carefully investigated, and the results of this work have not as yet become widely known. Let us consider the materials and methods of cyanide fumigation, then, in some detail.

"There must be a standard established in the production of the gas, if results are to be compared and conclusions drawn with any safety. The man who fumigates at a supposed certain

¹ Abstract from a paper read by H. T. Fernald, during Farmers' Week, February 16, 1912.

strength of cyanide, but who uses the 50 per cent cyanide, which is the usual strength kept at drug stores, instead of the 98 to 99 per cent material, will of course, get results widely different from those obtained by persons using the stronger article. We must use standard materials, then, if we use the same formula in their preparation."

261. Purity of the cyanide — "Three materials are necessary — potassium cyanide, sulphuric acid and water. We have to consider their quality and the quantity to use.

"It is important to use a cyanide which is practically pure. The 98 to 99 per cent grade manufactured by Merck is a reliable material, and the products of similar strength made by a number of other manufacturers are also satisfactory. With lower grades, less of the material from which the gas is formed is of course, available, and there is also a question as to what result the presence of other substances may produce. With 50 per cent cyanide, for example, there would be only half as much cyanogen to combine with the hydrogen of the sulphuric acid as with the 98 to 99 per cent grade, and if among the constituents of the other 50 per cent there should be something which would combine with the hydrocyanic acid gas as fast as it formed, there might be little or none of the gas left to do its work. Therefore, use a practically pure potassium cyanide."

262 The sulfuric acid. — "Perhaps the sulphuric acid is the most variable of the three factors used in fumigation. At least, it is exceedingly important that it should meet certain requirements if the treatment is to be satisfactory, as the use of a wrong grade of acid is liable to cause injury to the foliage. Commercial sulphuric acid is satisfactory, provided it contains no nitric acid, and is of the strength known as 66° Baumé. Such an acid should average 93 to 94 per cent of actual sulphuric acid, the other 6 or 7 per cent consisting of impurities of various kinds. Sulphuric acid is made either from free sulphur or from sulphur combined with iron or copper and known as pyrites. Ordinarily, the pyrites used, contains arsenic and other materials of a like nature. In the manufacture it becomes mixed with fumes of nitric acid gas, and when pyrites is used rather than sulphur, much more nitric acid becomes mixed with the sulphuric acid produced, than in the case where sulphur is taken. The nitric acid can be removed by refining, of course, but this increases the cost.

"The danger in having nitric acid present, is that it is energetic in its action, and also volatilizes readily. Accordingly, when sulphuric acid containing it, is added to water, the heat produced begins to volatilize the nitric acid, and when the cyanide is

added, it increases the heat, so that the passing off into air of the hydrocyanic acid gas causes the nitric acid also to pass into the air. When this condenses again on the leaves, its action is vigorous and also extremely injurious, causing burning wherever it touches.

"For the greatest economy of gas production, then, the acid should be of the grade known as 66° Baumé, and in addition it should be entirely free from nitric acid."

263 Proportion of the ingredients. — "Of the water, little need be said. It is, of course, possible that waters containing impurities might include something which could modify the chemical process to some extent, but this will in all probability never be the case."

The proportions to use of these different materials have been variously given at different times. One writer, who has been widely followed, says, "A half more acid, liquid measurement, than cyanide, and a half more water than acid, are used." Another suggests a 1-2-3 formula. Recent studies on this point have been based on the principle that when one chemical acts upon another to produce a third, the amount actually used is always the same, and that the presence of more than enough of either simply means a surplus of it left unchanged at the completion of the combination.

"The actual process of the combination of the chemicals is expressed as follows. $2 \text{ KCN} + \text{H}_2\text{SO}_4 = \text{K}_2\text{SO}_4 + 2 \text{ HCN}$. Potassium cyanide + hydrogen sulphate = potassium sulphate + hydrocyanic acid"

264. The excess of acid. — "If we take an ounce by weight of the potassium cyanide, we find that three-quarters of a fluid ounce of sulphuric acid is sufficient to give hydrogen enough to combine with all the cyanogen there is in the potassium cyanide. On the other hand, a little of the hydrocyanic acid may dissolve in the water present, instead of passing off into the air as a gas, and would thus be lost, so far as use goes. The addition of another quarter of an ounce of acid will heat the water more, and tend to drive the gas out, so that for this reason it seems to pay to use a little excess of acid over what is needed for the chemical process, to get more of the gas

"Too much excess of acid, however, produces trouble in a different way. The formula given shows that potassium sulphate is formed in addition to the hydrocyanic acid gas. Now, potassium sulphate, though a solid, dissolves in the water present, but if there is much spare sulphuric acid also present, less of the potassium sulphate dissolves, and instead it tends to form a crust cov-

ering the pieces of potassium cyanide not already acted upon, so that the sulphuric acid cannot reach these pieces to combine with them and produce gas. For this reason, then, too much acid is as undesirable as too little, and if after a fumigation has been completed, there is a solid or a slushy substance left in the dish, this indicates that either too little water or too much acid was used."

265. The action of the water. — "At present, then, the proper amounts to use seem to be one part by weight of cyanide, and one part by measure of acid.

"Water is not absolutely essential to the production of hydrocyanic gas by the action of sulphuric acid on potassium cyanide, as the acid could be poured directly upon the cyanide, and some gas be given off. The process would quickly come to an end, however, in this case, as the potassium sulphate formed would so coat over the cyanide that the acid would either fail to reach it or would do its work too slowly. Water is useful in dissolving both the cyanide and the potassium sulphate produced, and in hastening the chemical reaction, which is of importance, as the maximum amount of gas is needed as quickly as possible for effective results. If too little water is present, the potassium sulphate tending to coat the cyanide is not dissolved, and this delays the process if it does not in part prevent it. Then the heat produced by mixing the acid and the water is a great advantage, as it hastens the chemical reaction.

"It is evident that too little water will prevent the production of the maximum amount of gas. Experiment shows that too much water acts in the same way, more of the gas entering the water and thus reducing the amount in the air. A series of tests using varying amounts of water has shown that for the best results, there should be three times as much water as acid, and the best proportions of all three materials to use, therefore, become: cyanide, one part by weight; acid, one part by measure; water, three parts by measure."

266. The right order in mixing. — "It is desirable to utilize the heat produced by the addition of the sulphuric acid to the water, in order to hasten the production of hydrocyanic acid gas. Accordingly, the water should be placed in the jar first, and as the heat produced by adding the sulphuric acid is considerable, granite-ware dishes are preferable to earthenware ones, since the latter frequently crack from the heat. The sulphuric acid should be added to the water, and while hot, the cyanide should be dropped into the rest.

"To destroy any particular kind of insect, at least a certain

strength or density of the gas is necessary. This is also true for plants. Fortunately, the insects in most cases are killed more easily, *i. e.* with a smaller amount of the gas, than are the plants. At the present time, the main gap in our knowledge is a lack of knowledge as to how strong the gas must be in order to kill all the individuals of each kind of insect concerned. A strength sufficient to destroy all the plant-lice in a house would probably fail to kill the thrips; thus we must learn how strong the gas should be to accomplish the result desired, for each different kind of insect."

267. The use of contact poisons — When but few plants are attacked by mealy bugs or scale insects, contact poisons are frequently used to exterminate the pests. These poisons are various oil solutions, such as kerosene emulsion, whale oil soap or similar preparations. The solutions are applied with a brush, and the resulting chemical action on the bodies of the insects destroys the skin and tissue beneath.

CHAPTER XIII

CUT-FLOWER CROPS — CARNATIONS, ROSES AND CHRYSANTHEMUMS

THE business of flower-production for the supply of markets in cities and large towns is an important one. The selection of the species one decides to grow will depend in a large measure on the soil in that particular locality, the demand for the product and the interest of the grower in the species with which he is to work. Within recent years, there is a much wider range of species grown for cut-flowers. Roses, carnations, chrysanthemums, violets and sweet peas are in great demand, and are considered the standard florists' flowers. In addition to these, orchids, antirrhinum, mignonette and gardenias are grown quite extensively, while astilbes, marguerites, myosotis and stocks are somewhat less extensively grown. There is an increasing interest among flower-growers in annuals and herbaceous perennials which may be forced for cut-flowers.

CARNATIONS

268. Botanical classification. — Order, Caryophyllaceæ; Pink family; genus, *Dianthus* (Greek, *Jove*, and *anthos* — flower); species, *caryophyllus* (Greek, *caryon* — a nut, and *phyllon* — leaf, referring to fragrance of flower, which is like the clove tree). (Fig. 23.) The forcing carnation is var. *longicaulis*.

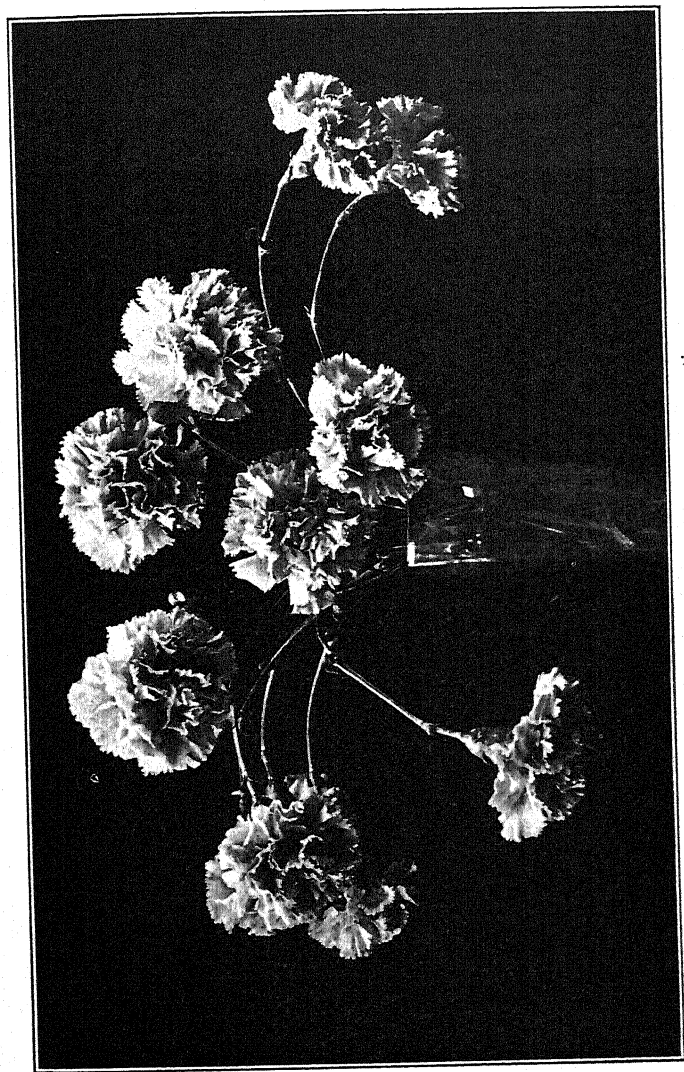


FIG. 23. — A vase arrangement of carnations.

269. Present-day carnation varieties and origin. —

1. *White*:

White Enchantress,	L. S. Marquisee, 1905
White Perfection,	F. Dorner & Sons, 1906.
White Wonder,	F. Dorner & Sons, 1910
Matchless,	Cottage Gardens Co., 1912.
2. *Red*.

St. Nicholas,	Baur & Smith, 1907.
Bonfire,	E. G. Hill Co., 1911.
Commodore,	E. G. Hill Co., 1912.
Comfort,	S. M. Merwarth & Bros., 1912.
The Herald,	Chicago Carnation Co., 1912.
Champion,	F. Dorner & Sons Co., 1914.
Beacon,	Peter Fisher, 1907.
Gorgeous,	Peter Fisher, 1912.
Eureka,	A. Roper, 1914
3. *Deep crimson*:

Pocahontas,	Baur & Smith, 1911.
Princess Dagmar,	Patten & Co., 1912.
Harlowarden,	Chicago Carnation Co., 1903.
4. *Light pink or shell pink*:

Enchantress,	Peter Fisher, 1903.
Enchantress Supreme,	Dalledouze Bros., 1913.
Pink Delight,	F. Dorner & Sons, 1908.
Winsor,	F. R. Pierson, 1905.
Dorothy Gordon,	Joseph Heacock & Co., 1908.
Gloriosa,	F. Dorner & Sons, 1910.
Alice,	Peter Fisher, 1914.
Alice Coombs,	A. Roper, 1914
Laura Weber,	Chas. Weber, 1914.
Pink Supreme,	T. H. Leach, 1914.
5. *Dark pink*:

Mrs. C. W. Ward,	Cottage Gardens Co., 1910.
Philadelphia Pink,	S. S. Skidelsky & Co., 1914.
Northport,	J. D. Coekeroft, 1913.
Rose Pink Enchantress,	Bruno Schroeter, 1906.
Rosette,	F. Dorner & Sons, 1912.
6. *Yellow*:

Yellow Prince,	F. Dorner & Sons, 1913.
Yellow Stone,	F. Dorner & Sons, 1913.
7. *Variegated*:

Benora,	Peter Fisher, 1912.
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270. Propagation by seeds.—The carnation is reproduced by seeds only to a limited extent. Usually a carnation-grower has a few seedlings for the production of new varieties. Cross pollination of flowers, which is essential for the production of seeds, is a blending of the characters of the two parents, and marked variations in the resulting plantlet usually occur.

Carnation plants are grown principally for the production of large numbers of blooms. This causes a weakening of the plant; varieties tend to lose desirable characters, or to “run out” after a few years. New varieties are necessary to keep up the standard of perfection in blooms.

271. Propagation by cuttings.—The common method of increasing carnation plants is by cuttings. These are taken during the months of February and March, from parent plants which show strong vigor, freedom from disease and productiveness of bloom. The material usually selected for cuttings is near the base of the flowering stems. As a rule, these side-shoots give vigorous plants, while cuttings taken from lower parts of the plant often result in what is termed “grassy” plants. An abundance of foliage is produced on such cuttings, but few flowers. Cuttings taken from higher up on the flowering stem have a tendency to shoot up a flower stalk quickly, and a weak plant is the result. There is a difference of opinion regarding the advisability of cutting back the foliage after cuttings are taken. Some prefer to take a short cutting, and not to cut the terminal leaves. There is a belief that this injury to the foliage makes the cuttings more susceptible to disease. Other growers shorten considerably the foliage of cuttings. As soon as cuttings are taken, they are inserted in sand in the cutting bench, and given a uniform temperature.

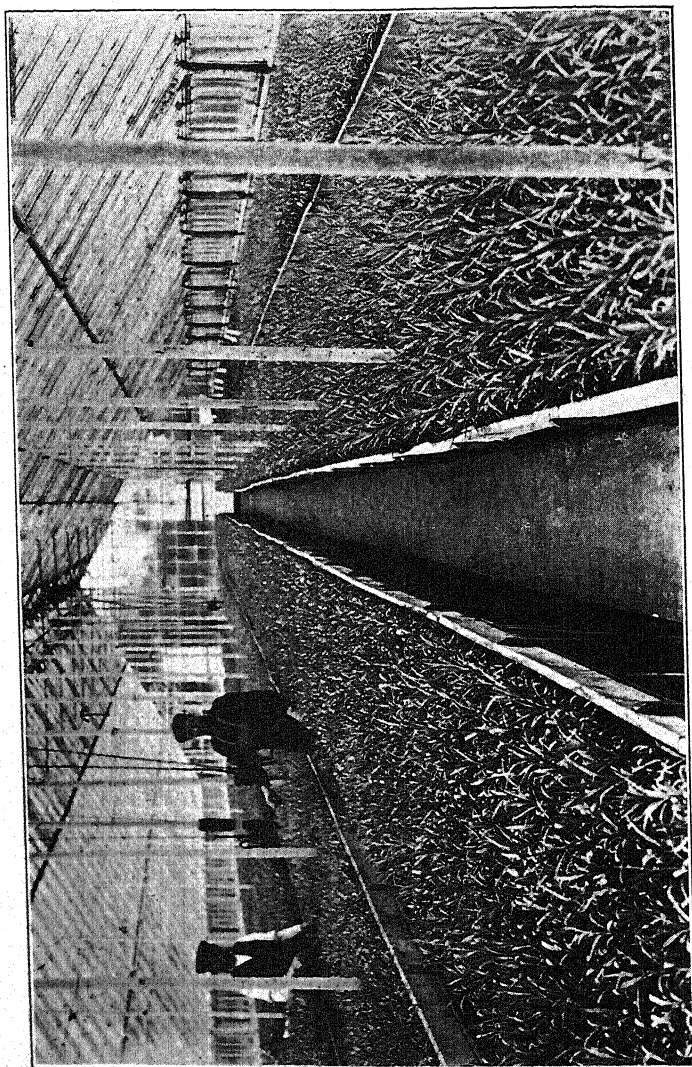


FIG. 24. — A house of young carnation plants.

272. Care of rooted cuttings (Fig. 24). — As soon as the cuttings have developed roots from one-fourth to one-half inch in length, they are potted in two-inch pots, or put into flats. For the lighter soils, flats are preferred, as there is less injury to the rootlets when the plants are transferred to the field. They economize room and eliminate much time and trouble in handling pots. A ball of roots is thus formed at the base of the stem, and in later transplantings, the growth of the plant is not seriously checked. For heavier soils, pots may be used.

In potting the plants from the cutting benches, or in putting them into pots, great care should be taken not to set them too deeply in the soil. Deeply set cuttings usually die, especially if over-watered, and plants so set are more subject to stem-rot. The soil for potting should not be very rich. As soon as the plants are potted, they should be thoroughly watered, and at no time should they be allowed to dry out. There is a tendency to neglect plants during the early stages of their growth, and this is exceedingly detrimental to a healthy growth of the matured plants. Cuttings should be kept growing vigorously and never allowed to become pot-bound. The best results are obtained by growing young carnation plants in a comparatively low temperature, and a soft, succulent growth should never be permitted. As soon as the weather is sufficiently warm, the plants should be placed in cold frames to harden the tissue before they are planted in the field. In New York State, this planting will usually be about the first of May. They should have been in cold frames at least two weeks before this date.

273. Field culture. — Carnations are usually grown for a time in the field. This insures a firm growth, which

is practically disease-resistant. The soil is prepared the previous fall. It is plowed, then a light coating of manure is spread on the soil late in November and turned under. The ground is left rough during the winter, and in the spring it is plowed again as early as possible, and then disked several times before planting. The planting should be done as soon as the danger of frosts is over. The most common practice in field culture is to plant the carnations about a foot apart, in rows eighteen inches apart. This allows hand cultivation during the summer. Where plenty of land is available, some growers prefer to plant in rows three feet apart, making it possible to use a horse cultivator, and hand hoeing.

During the summer, the plants should be cultivated frequently and the surface soil kept loose and open. From time to time the plants should be gone over carefully, and the leaders pinched out to form stocky plants. This requires good judgment on the part of the grower, for varieties which naturally spindle need more severe pinching than do those which produce an abundance of foliage near the base. In the first pinching, much care should be taken to encourage the plants to branch some distance above the surface of the soil. This renders them less liable to stem-rot. Varieties which naturally come into bloom late should not be topped after the middle of July.

274. House culture in summer. — Where land is too valuable and difficult to obtain, some growers set the plants directly in benches in early summer. Abundant ventilation is given, and everything possible done to induce a strong, healthy growth. As the plants receive no check from transplanting in late summer, they flower earlier in the fall than do field grown plants. Many growers,

however, believe that plants grown in benches during the summer are weak and more susceptible to disease. The majority of growers plant carnations in the field for the summer.

275. Preparation of the house for permanent planting.

— The old plants are usually removed from the houses early in June, for after one season the flowers become small and the plants often become covered with red-spiders. As soon as the plants are removed, the benches should be repaired and thoroughly disinfected to rid them of all insects and diseases. Most carnation-growers prefer to use raised benches rather than solid beds, for it is easier to control moisture conditions, and diseases are less liable to trouble.

276. Filling the carnation benches. — The soil should have been prepared as described in Chapter X, using a compost of four parts of sod to one of manure. It should be thoroughly decomposed. Select a cloudy, windless day for filling the houses, for then the plants will wilt less, and the fibrous roots will not dry. Watering the soil before planting should not be practiced, and the plants should be set soon after the benches have been filled and before the soil has time to dry out.

277. Lifting the plants in the field. — Great care should be taken not to injure the plants in taking them from the field. Some varieties have a scanty root system, and such should be most carefully handled. In clay soils, some of the earth is taken into the houses, but in the lighter soils, most of the field soil is shaken from the roots. More soil will be retained if the young plants have previously been grown in pots, instead of in flats. If the plants are handled carefully, the shaking of the soil from the roots is not injurious. Plants of approximately the same size are

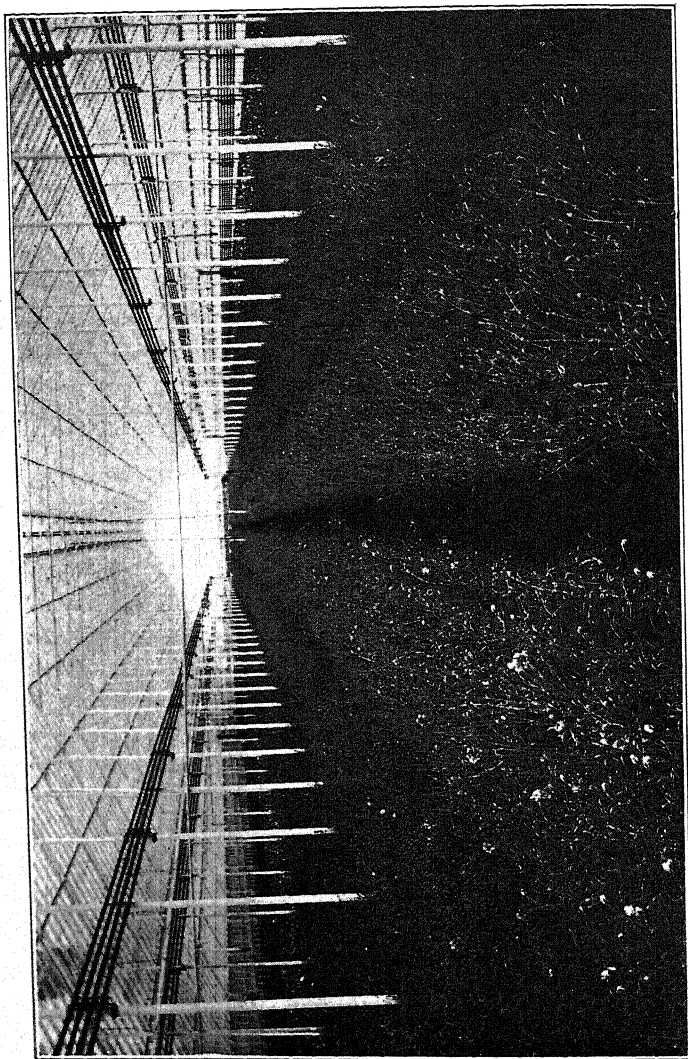


FIG. 25. — A modern greenhouse filled with carnations.

selected for planting in the same bench. If there are not enough of one size to fill the bench, a second selection is made for the remainder of the bench.

278. Planting the houses (Fig. 25).—The plants should be planted in the benches as soon as they are dug. It is important that the soil in the benches be evenly packed so the moisture contents will be uniform. In planting, the roots should be distributed evenly throughout the soil, and the plants should be set no deeper than they were in the field. Deep planting encourages stem-rot. The soil should be firmly packed about the roots. This brings the moist soil in contact with all root areas and favors the capillary action of the soil moisture, which in a degree prevents wilting.

After the plants are set, they are given a light syringing. Heavy watering should not be allowed, for it makes the soil muddy, excludes air, and root action does not begin promptly. When the plants become established, heavier waterings may be given. It should be remembered, however, that heavy waterings at the crown usually induce stem-rot. Many growers give the house a light shading just before planting.

279. Cultivation.—The surface soil in carnation beds should be stirred frequently. This keeps the weeds in check and also provides for aëration of the soil, besides assisting to regulate proper moisture conditions.

280. Carnation supports.—As soon as the plants are well established and the blooming stems begin to develop, wire supports should be given. The usual method is to run several wires lengthwise of the row, and to use twine or similar material for cross-supports. This allows freedom of growth, while it gives sufficient support to make the flower-stems straight and stiff.

281. Temperature and moisture conditions in carnation houses. — The house temperatures should be carefully regulated, for on this depends in a large measure the vigor of the plants. A night temperature of 52° to 55° should be maintained, and during the day the mercury should rarely go above 70°. The atmosphere should be fresh, and sufficiently moist to prevent attacks of red-spiders. Syringing the foliage, and dampening the walks on sunny days, should be practiced.

282. Feeding. — After the plants have been growing for about two months, they will have practically exhausted the soil. Additional food should then be given, as fast as the plants can use it. The food may be in the form of liquid manure or light mulches.

283. Disbudding carnations. — The plants should be looked over frequently and all side buds removed. This favors the development of a perfect flower. Flowers should be cut as soon as they are fully developed. This is indicated in a measure by the maturity of the stigma. If left uncut, the plant's vitality is weakened.

ROSES

284. Botanical classification. — Order, Rosaceæ; genus, *Rosa* (an old Latin name); species of indoor roses are largely the blended product of *R. gallica* and *R. chinensis*.

285. Present-day varieties forced under glass, and their origin. —

1. *Pink*:

Killarney,	Dickson & Son, 1898
Double Pink Killarney,	R. Scott & Sons, 1911
My Maryland,	Cook, 1909
Antoine Rivoire (or Mrs. Taft),	Pernet-Ducher, 1896
J. L. Mock,	Leenders, 1901
Mrs. Charles Russell,	Montgomery, 1913
Killarney Brilliant,	Dickson & Son, 1914

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|---------------------|---------------------------|
| Killarney Queen, | J. A. Budlong & Son, 1909 |
| Mme. Abel Chatenay, | Pernet-Ducher, 1895 |
| Ophelia, | Wm. Paul & Son, 1912 |
| Mad. Cecil Brunner, | Ducher, 1881 |
2. *White*
- | | |
|----------------------------|------------------------------------|
| White Killarney, | Waban Rose Conservatories,
1909 |
| Double White Killarney, | J. A. Budlong & Son, 1910 |
| Kaiserin Augusta Victoria, | Lambert & Reiter, 1891 |
3. *Red*
- | | |
|-------------------------|--------------------------|
| Richmond, | E. G. Hill, 1905 |
| Hadley, | Montgomery, 1913 |
| Radiance, | Henderson, 1909 |
| Rhea Reid, | E. G. Hill, 1908 |
| Prince d'Arenberg, | Soupert et Notting, 1910 |
| Hoosier Beauty, | F. Dorner & Sons, 1915 |
| Mrs. Francis Scott Key, | John Cook, 1914 |
4. *Yellow, or orange:*
- | | |
|------------------|----------------------|
| Lady Hillingdon, | Lowe & Shawyer, 1910 |
| Mrs. Aaron Ward, | Pernet-Ducher, 1907 |
| Sunburst, | Pernet-Ducher, 1912 |
| Irish Fireflame, | Dickson & Sons, 1913 |

286. Propagation by seeds. — New varieties of roses have not been introduced to the same extent as have new varieties of carnations. A few Americans have interested themselves in this line of work. Among them are E. G. Hill, of Richmond, Indiana; Alexander Montgomery, Jr., of Hadley, Massachusetts; and John Cook, of Baltimore, Maryland. These men have already introduced several seedlings of value.

287. Propagation by cuttings. — Propagation of roses by cuttings is practiced to a considerable extent, for many varieties of roses are still grown on their own roots. The cuttings are usually taken early in the season so that strong plants may be ready for planting in the houses by July. The general method of making and caring for cuttings is described in Chapter IX. It is necessary that

considerable care be taken to insure at least ten degrees of bottom heat in the benches.

The cuttings should be taken when the wood is comparatively cool. The wood selected should be plump and firm. Avoid all wood which is soft and succulent, or hard and fibrous. The cuttings may be made with but one bud, or they may have two or more buds; much depends on the texture of the wood and the distance between the buds. In short-jointed varieties, it will be necessary to make cuttings with two or more eyes.

Propagation by grafting was quite fully discussed in Chapter IX.

288. Potting the rosé cuttings. — As soon as the roots are about one-half inch in length, the plants should be potted, for if left too long in the cutting bench, the tissue of the wood hardens and the subsequent health of the young plant is injured.

The soil for the first potting should contain but little fertilizer. A small amount of thoroughly decomposed manure or bone-meal will not hurt the young plant, but no active fertilizer should be used. The cuttings should be potted firmly in two or two and one-quarter-inch pots, placed on a bench where there is good air circulation, and thoroughly watered. A table is preferable to a bench, for if the sides are high, they cause the atmosphere to become stagnant, and diseased conditions may prevail. It is also easier to syringe the foliage to prevent attacks of red-spider, if the plants are on tables. The young plants should be placed out of the reach of drafts, and shaded for a few hours only, during the hottest part of the day. Their vitality is low at this period of growth, and there is danger of attacks of mildew.

The young plants require the best of care, and as soon as

the soil becomes filled with feeding roots, they should be re-potted into the next larger size pots.

289. Preparation of soil for house culture. — This has been discussed in a general way in Chapter X. As a rule, the soil for large rose houses is prepared in the field, rather than in compost piles. Hand labor is eliminated by this method, which means a saving of time and money.

290. Season of year for planting roses in houses. — All roses should be benched by the first of July, for it is essential that they become established ready for the production of flowers in the early fall. One grower states that after the middle of July, each day's delay represents a loss of twenty-five dollars in planting ten thousand square feet of bench surface.

291. Solid benches or raised beds. — There is a wide difference of opinion regarding the comparative merits of raised benches and solid beds. In general, solid beds are preferred. If good drainage is provided, the results of the two are equally good. It is advocated by some growers that houses with solid beds heat more easily and uniformly than do those with raised benches. As grafted roses are grown for several years in the same beds, it is considered an advantage to use solid beds for this stock.

292. Bench construction. — Benches or beds for roses should be narrow. The best grades of roses are grown on the outside plants, where the light and atmospheric conditions are best. Most growers have the beds four feet wide. They plant four rows, placing the plants sixteen inches apart in the row. This distance, of course, varies with different varieties. The sides of the bench should be six inches deep, which allows for top-dressing. When solid beds are used, they are from eighteen inches to two feet

high, and the soil need not be over six inches deep. The sides of the beds may be of wood, concrete or brick.

293. Filling the beds.—Filling the beds should be done quickly and in the most economical manner. Some growers place planks along the center of the bench or bed, and bring the soil in with a wheelbarrow. When rose houses are long, as they are in many up-to-date commercial establishments, it is necessary to employ other methods. Some have movable sash along the sides of the houses. Carts filled with loam are drawn to the sides of the houses, and the soil thrown into the benches or wheeled from one to another. In other establishments, a movable track is used. Care should be taken to fill the benches evenly, and not to have the soil too moist.

294. Planting the roses in the houses (Fig. 26).—The plants should be placed in the benches as soon as possible after they are filled. The surface should first be leveled and carefully marked, that the rows may be even. It is important that the plants be evenly spaced, for later they will need wire supports, and much difficulty is experienced in placing the wires if the planting is irregularly done.

The stock of plants is examined carefully, and strong, healthy plants of uniform grades are selected. They are set a little deeper in the bed than they were in the pots. This is especially true of grafted stock, for all bud development should take place above the union of stock and cion. After the plants are set, the soil should be compacted. This firming will be more beneficial in lighter soils than in clay soils. The soil should then be moistened, not water-soaked, and no more water applied until root action has started. The foliage should be sprayed every bright day, and the walks in the houses dampened.

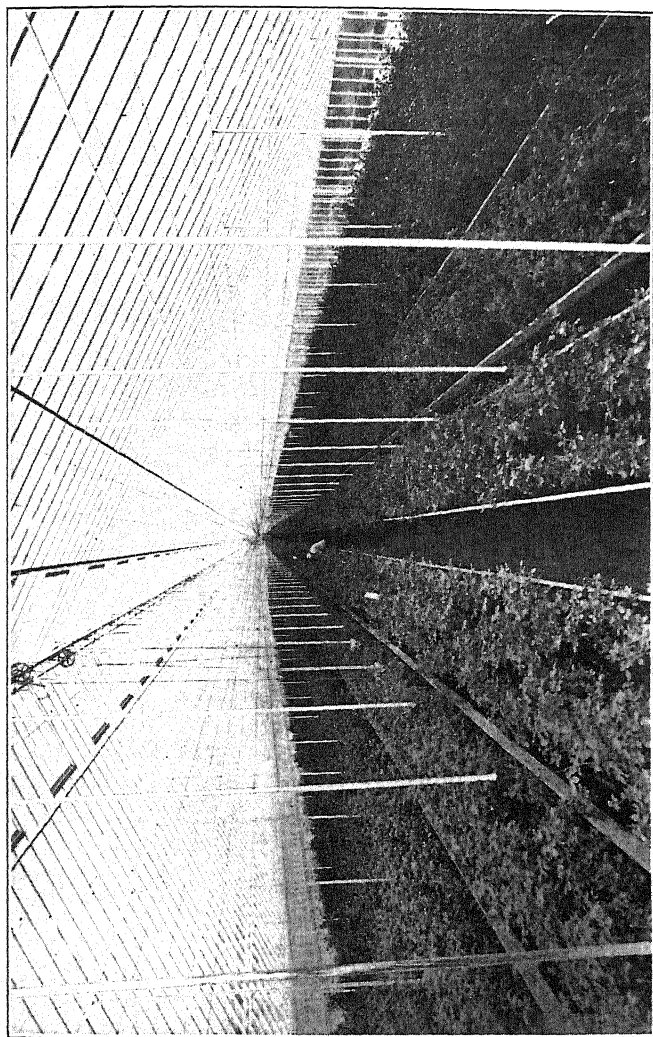


FIG. 26. — A modern rose house.

295. Subsequent care of roses. — The surface soil of the benches should be stirred frequently to keep down the weeds, to assist in aërating the soil, and to regulate its moisture contents. As soon as the surface soil becomes filled with the feeding roots, care should be taken not to stir it too deeply or these roots will be injured.

The plants should be watched carefully and all diseased leaves removed. This is very important during the first few weeks after planting, for the plant's vitality is low, due to its change of environment, and if a disease is present, it will spread rapidly. When the plants have become established and all the vital processes are normal, the danger of disease is lessened.

The first six weeks after the roses are planted are important ones. Every effort should be made to promote a strong, healthy root and foliage development. The plants are not allowed to bloom, the temperature is kept low, and abundant ventilation is given. About the first of September, a few of the stronger buds on each plant are allowed to develop. When flowers are desired for a special date, the shoots are pinched out about eight weeks previous in the winter months, and six weeks previous in the late spring and mid-summer. Most growers prefer to have a succession of bloom in the houses, therefore, certain sections of the house are disbudded so they will come into flower at a given date, and other sections a little later. This enables the grower to supply his customers with a continuous bloom.

When the plants become well established in the benches, provision should be made to support them. No. 18 wire is run lengthwise of the bed about three feet from the soil. No. 9 galvanized wire stakes are placed in the soil beside the plant, and are held to the wire above, by a wire clip

or by twine. The branches are tied to this stake. This method of securing the plants gives excellent air circulation and permits them to take a natural habit of growth. It also allows the workmen to keep the plants clean and the soil stirred.

296. Desirable varieties of outdoor roses —

(1) *Hybrid Perpetuals*

Frau Karl Druschki	Magna Charta
General Jacqueminot	Hugh Dickson
Paul Neyron	Prince Camille de Rohan
Mrs. John Laing	Gloire de Margottin

(2) *Bourbon*

Souvenir de la Malmaison
 Agrippina
 Beauty of Rosemawr
 Champion of the World
 Hermosa
 Burbank

(3) *Polyantha or Baby Rambles*

Madame Norbert Levavasseur or Baby Rambler	Louise Welter
Katherine Zinet	Clothilde Soupert
Mrs. Wm. Cutbush	Orleans

Rambler or Multiflora roses.

American Pillar	Crimson Rambler
Philadelphia	Mrs. F. W. Flight
Tausendschon	

Hybrid Wichuriana.

Dorothy Perkins	Excelsa
Lady Gay	Hiawatha
White Dorothy Perkins	Alberie Barbier
Evangeline	Prof. C. S. Sargent

Prairie roses.

Queen of the Prairie
 Baltimore Belle
 Setigera

Sweetbrier roses:

Anne Geierstein	Lady Penzance
Meg Merrilies	Lord Penzance
Common Sweetbrier	

Rugosa:

Conrad F. Meyer	New Century
Rugosa alba	Sir Thomas Lipton
Rugosa rubra	

Hybrid Teas:

General McArthur	Kaiserin Augusta Victoria
Killarney	Souvenir du President Carnot
Prince de Bulgarie	Gruss an Teplitz

Teas

Lady Hillingdon	Helen Gould
Wm R. Smith	Catherine Mermet

Moss:

Blanche Moreau	Glory of the Mosses
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Hardy Yellow

Harrison's Yellow	Persian Yellow
Soleil d'Or	

297. Location for the outdoor rose bed. — The outdoor rose bed should be in an airy location, but one somewhat sheltered from high winds. A southern exposure is best, and one which is open to the morning sun. A rose bed too shady is subject to mildew. If protected by trees, these should be at such a distance as not to sap the fertility of the soil. A location somewhat elevated is desirable, the plants being less liable to injury by late spring or early fall frosts.

298. Soil. — A deep, rather heavy loam, with considerable clay, is best suited for most species of roses. Such a soil is especially good for the hybrid perpetuals. A lighter, warmer soil is better adapted for the teas, hybrid teas and the Bourbons. The yellow and the Scotch roses are less particular than other types, while the rugosa adapts itself to any soil. The soil for the teas and the hybrid teas should be well drained or they will be attacked by black-spot. If the soil is not of the right kind, the beds can easily be filled with the proper soil. The area to be

planted should first be filled in with broken stone, bricks or other coarse material, then a fine layer of soil put on top, and the remainder of the bed filled with loam of the character mentioned. It should be composted with at least one-sixth of well-rotted cow manure.

299. Size of beds. — The beds should be small enough so the bushes can readily be reached and the soil stirred frequently from the walks. Long, narrow beds are best, of a width not exceeding five feet. They may be of any length. The paths may be of grass or cinders. Grass walks are more attractive and are more easily kept than are those of cinders.

300. Selection of rose stock. — As a rule, better blooms are produced on budded stock. The first expense is greater, but the duration of the varieties is longer, and the plants give enough better satisfaction to offset the additional cost. Strong-growing varieties, like *Magna Charta*, will grow well on their own roots, but weaker-growing varieties are practically useless unless budded. When grown on their own roots many of the varieties have a greater tendency to disease. It is thought best to buy two-year-old plants, and to get field-grown stock from nurseries, rather than pot-grown plants. When grown in pots, the plants frequently become pot-bound and the growth the first year is weak. The roots do not spread quickly into the surrounding soil, but remain matted at the base of the plant. If potted plants are used, care should be taken to break the root system before setting in the soil.

301. Planting out-of-doors. — Spring planting generally gives the best results. The stronger varieties of hybrid perpetuals, rugosas, yellows, Scotch and climbers may be planted in the fall, about the first of November, and

heavily mulched with leaves. The larger part of the hybrid perpetuals should be planted in the spring just as soon as the frost is out of the ground. The teas are better planted about May 1 after all danger of late frosts is past. All varieties of the hybrid perpetuals should be planted at least twenty inches apart. Fifteen inches apart will be about right for the hybrid teas.

As soon as the plants are received, they should be examined carefully; and if the wood is shriveled, they should be dipped in water or buried in a trench for about three days. If frozen when received, they should not be handled, but placed in a shady location where they will thaw gradually. It is best to unpack in a place sheltered from wind and sun. Before planting, all broken roots should be cut off with a sharp knife. This is very important, for bruised tissue never heals and if allowed to remain, the root system easily becomes diseased.

302. Depth for planting roses. — Care should be taken not to plant too shallow. This results in weak, spindling growth, and many suckers are liable to spring from the stock. On the other hand, they should not be planted too deeply in the soil or the roots will be smothered. After the soil has become permanently settled, the union of the stock and cion should be about two inches below the surface. The hole should be made large enough to accommodate all the roots without crowding, and they should be spread out carefully and horizontally. The soil should then be packed firmly about them and watered. After watering, the surface soil should again be loosened and covered with a light mulch of strawy manure.

303. Cultivation. — During the summer, the soil should be stirred frequently and kept free from weeds. This stirring should be lightly done, however, or the feeding

roots will be injured. After a heavy rain, the soil should be loosened as soon as it is in a condition to be worked. Outgrowths from stock should be watched for and immediately cut off, as they sap the vitality of the budded section. Outgrowths may be recognized by the wrinkled foliage and the prickly character of the stems.

304. Syringing and watering. — An abundant supply of water is invaluable in the rose garden, for nothing preserves the foliage in as healthy a condition as a vigorous spraying every bright morning. It not only keeps the foliage fresh and firm, but it retards the spread of insects.

305. Cutting the flowers and fruits. — The flowers should be cut daily, care being taken to leave one or two outward-pointing buds at the base of the stem. As a rule, the more flowers cut, the more are produced. Faded flowers should be carefully removed, and no seed pods allowed to develop, for the production of seeds saps the plant's vitality. This applies more especially to the hybrid perpetuals and hybrid teas. *Rosa rugosa*, *R. setigera*, *R. carolina* and other species, however, produce an abundance of fruit which remains on the bushes during the early winter. These are most attractive, and in such cases, the fruits should be allowed to develop.

306. Disbudding roses. — Many hybrid perpetual varieties have a tendency to produce flowers in clusters, and the buds open at different periods. If all are allowed to develop, the center flower should be removed as soon as it is mature; it is better to remove some of the weaker buds early in their development, allowing only two or three to develop in a cluster. The teas and the hybrid teas are more satisfactory if all side buds are removed and only a single flower on each stem is allowed to develop.

307. Shading. — There is a tendency in some varieties

for the petals to become blackened and wilted before the flowers fully develop. Such varieties should be shaded from intense sunlight. This may be done by the use of cheesecloth on supports; but the screen should be high enough to allow an excellent air circulation around the plants.

308. Feeding.—As a fertilizer for roses, nothing is equal to cow manure. It does not need to be decomposed, for its character is not sufficiently active to injure even the most delicate roots. The rose beds should be given a top-dressing every fall. This not only fertilizes the soil, but it acts as a preventive against winter-killing. During the summer, an occasional watering with liquid manure will be beneficial. An application may be given as soon as the flower-buds begin to form in the spring, and it may be continued as often as once a week throughout the summer. During July, the rose beds should be given a mulch of strawy manure, to prevent the hot sun from injuring the delicate, feeding roots which are always near the surface of the soil.

309. Winter protection.—As soon as the ground freezes, a heavy mulch of strawy manure should be given the rose bed. There should be a cone of mulch ten inches high about each plant. The tops should then be covered with an orange or grapefruit box. This prevents the alternate freezing and thawing of the soil, and the buds at the base of the plant are not injured. The heavy spring rains will wash considerable nourishment from this mulch into the soil, and this aids to start the plant into vigorous growth early in the spring. About the first of April, the mulch should be removed, a part at a time.

The teas, hybrid teas and some of the more delicate climbers should be covered completely with leaves or

straw; this should not be done before the last of November, or the plants may be smothered. The hybrid perpetuals rarely require straw protection.

In the northern states, standard roses which are budded high on manetti stock should be buried in a trench at least two feet deep which has first been lined with straw. The standards are dug from the soil where they have been growing during the summer, and laid in this trench. They are covered with soil to a depth of at least six inches, and the soil covered with leaves. Near the middle of April they may be taken out again and planted.

310. Pruning roses. — Hybrid perpetuals, teas and moss roses are best grown as bushy plants. They should be severely pruned in early spring, removing from two-thirds to four-fifths of the last season's growth. All weak shoots should be cut out. This pruning results in strong canes which produce large flowers. Weaker varieties should be pruned more severely than vigorous growers.

Climbing roses need not be pruned as severely as those just described. The older canes should be removed from time to time and weak growth cut out so that strong canes may produce many flower-spurs for the next season. The half-climbing roses of the multiflora type, and the sweet-briers, are pruned as little as possible, and only the weaker growths are removed. The flowering wood is left on the plants if fruit for winter effects is desired.

The trailing roses are seldom pruned. Such briers as the yellow and Scotch produce their flowers on short spurs, and, therefore, are not severely pruned. The Scotch and the rugosa, however, are benefited by being cut to the ground about once in six or seven years. When pruned extensively they produce immense quantities of foliage and comparatively few flowers.

311. Forcing hardy roses. — Within recent years there has arisen a demand for potted roses for Easter trade, and many of the hardy varieties are now grown for this purpose.

312. Types most generally forced. — The roses of the rambler type are especially suited for forcing as potted plants. Several of them are dwarf and make compact, attractive plants. It is possible to train others of the climbing type into unusual forms, and such are sold as novelties. Many of the hybrid perpetuals also force easily.

313. Securing the stock. — Stock of these roses may be bought from a nurseryman or the plants may be propagated from cuttings. The cuttings are usually made from half-ripened wood and inserted in a hotbed in late summer. When rooted, they are put into two and one-half inch pots and grown in the greenhouse throughout the winter, then planted outside the following spring. Plants two or three years old are most satisfactory for forcing.

314. Preparation of ramblers for forcing. — To secure good results from forcing the rambler roses, the plants should be dug from the field early in the spring and put in rather large pots. When well established, they should be plunged in the open ground, and every effort made to encourage strong growths of wood during the summer. The wood should be supported on a stake or fence so that it will ripen thoroughly in the fall. The plants should be well fed and watered during the season, and receive all the sun and air possible. As fall approaches, the wood should be allowed to ripen gradually. After several heavy frosts, the plants are lifted and stored in a frame until such a time as is desired to force them.

It takes about ten or twelve weeks from the time they are brought inside, to prepare them for sale. This depends, however, upon the maturity of the wood and the temperature at which they are kept. As soon as they are brought inside, the long canes should be tied into the shapes desired. Wire stakes are used for these forms, but they are eventually completely hidden with foliage and flowers.

315. Temperature and light requirements. — The temperature at first should not exceed 45° at night, and water should be applied to the soil moderately, but the tops should be syringed several times during the day. After two or three weeks the temperature may be raised to 50° , and later, when the buds have formed, it may gradually be increased to 60° . Roses which are forced in moderate heat will have better keeping qualities. The plants should be kept near the glass and turned frequently so that the buds on all sides will develop evenly, and symmetrical plants thus formed. The baby or dwarf ramblers, the hybrid perpetuals and hybrid teas may be forced in the same way.

316. Forcing hybrid perpetuals. — The hybrid perpetuals are grown more especially for cut-flowers; therefore they may be planted in boxes which are about three feet long, eight inches wide and eight inches deep. They may be placed along the side of the houses in which the teas and hybrid teas are grown for cut-flowers.

317. Use of unsold plants. — Any plants left from the spring sales may be plunged out of doors in the early spring, and they will make good plants the following spring. They should be re-potted in rich loam before plunging, and should then be treated the same as are the rambler roses.

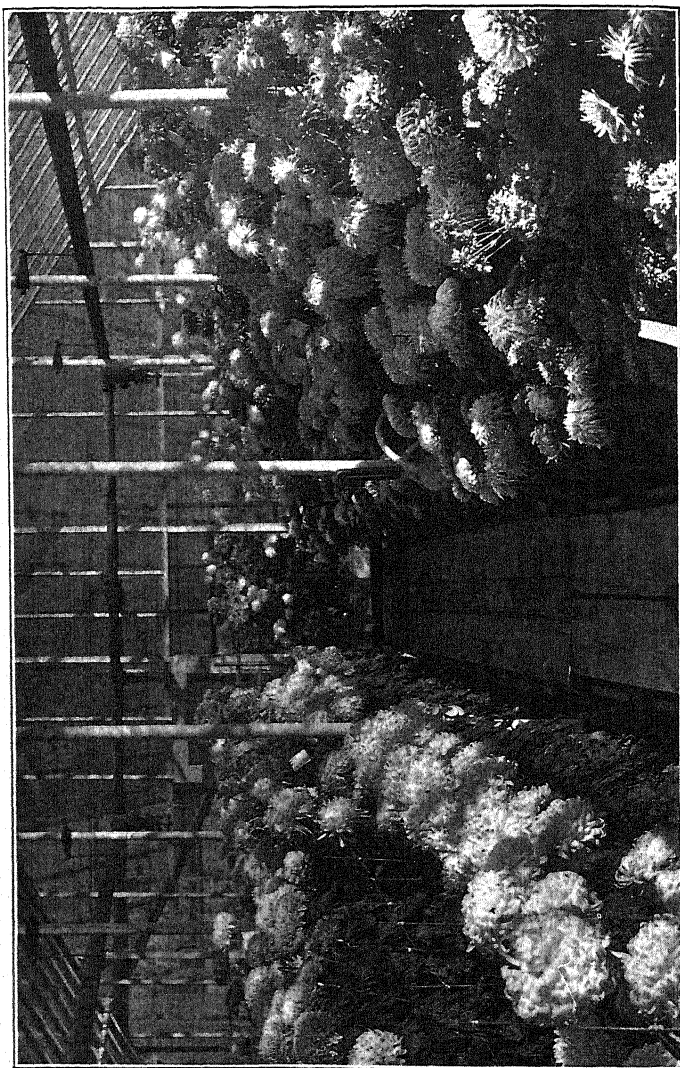


FIG. 27.—A house of commercial and exhibition chrysanthemums.

CHRYSANTHEMUMS

318. Botanical classification. — Order, Compositæ; Genus, *Chrysanthemum* (from the Greek meaning golden flower, referring to the color of the earlier types) Species: the blended product of *C. morifolium* and *C. indicum* has given most of the present-day varieties of so-called Japanese and Chinese chrysanthemums. Other species of general interest to flower-growers are *C. coccineum* — pyrethrum; *C. Parthenium* — feverfew, *C. frutescens* — marguerites; *C. præaltum* var. *aureum* — golden feather.

319. Important present-day varieties in different colors (Fig. 27). —

(a) *Some standard commercial varieties:*

Yellow:

Golden Glow	Golden Chadwick
Chrysolora	Major Bonaffon
Yellow Ivory	Ramapo
Yellow October Frost	Yellow Eaton
Monrovia	

White

Smith's Advance	Chadwick's Improved
October Frost	White Bonaffon
Early Snow	Wm. Turner
Polly Rose	Timothy Eaton
Ivory	December Gem

Pink:

Unaka	Chadwick's Supreme
Glory of the Pacific	Dr. Enguehardt
Pacific Supreme	Wm. Duckham
Pink Ivory	Patty

(b) *Excellent exhibition varieties are:*

Mrs. G. C. Kelly, upper part of petals cerise, lower old rose.
 Rayonarte, light pink.
 F. S. Vallis, yellow.
 Rose Pockett, bronze yellow.
 Pockett's Crimson, crimson with golden tips to petals.

M Loiseau Rousseau, lavender-pink.

F. E. Nash, light pink.

Mary Donellan, bright yellow.

Merza, white.

Naomah, white.

Reginald Vallis, plum color.

Yellow Miller, yellow.

T. Carrington, dark red

Petaluma, copper colored.

(c) *Anemones*:

Garza, white with yellow center.

Diantha, white with cream center.

Mary Colladay, lavender-pink.

Miss Ida Kroeschell, light yellow.

Alpine Glow, white tinged with pink.

(d) *Pompons*:

Klondike, bright yellow.

La Purite, pure white.

Fairy Queen, light pink.

Diana, white.

Zenobia, clear yellow.

Clorinda, bronze.

(e) *Singles*.

Gertrude, white.

Peter Pan, copper colored.

Arlee, golden amber.

Merstham Jewel, terra cotta, with golden points.

Miss Irene Cragg, white.

Ladysmith, pink.

Silvia Slade, deep rose.

Mizpah, red.

(f) *Hardy varieties*:

Carrie, yellow.

Queen of the Earlies, white.

Champagne, ruby red.

Hermine, white.

Eden, rose.

October Gold, old gold.

320. Classification as to types of bloom. — In general, chrysanthemums are classified, according to the character of the flowers, into more or less well-defined types. Those

recognized by the Chrysanthemum Society of England, are as follows:

Incurved type. — The incurved type is often called the Chinese. The flowers are nearly globular in form and regular in outline. The florets are smooth, rounded, or somewhat toothed at the top and sufficiently long to form a graceful curve. A hollow center, roughness in blooms and unevenness of outline, with a lacking in freshness of the outer petals, are serious defects. Many of the varieties of the commercial type, such as Major Bonaffon, Polly Rose and Dr. Enguehardt, come in this group.

Japanese. — The Japanese group includes those varieties with long, loosely arranged florets. These florets may be flat, fluted, quilled or tubulated, and may be incurved or reflexed. The flowers vary much in form, size and color. Many exhibition varieties come in this type, such as M. Loiseau Rousseau, F. E. Nash, Yellow Miller and Petaluma.

Anemones. — The anemones have high, neatly-formed centers of elongated, quilled florets, surrounded by flat, more or less horizontally arranged ray-flowers. Examples of this type are Garza and Alpine Glow.

Pompons. — The blooms in the pompon section may be somewhat flat or nearly globular. They are very neat and compact, formed of short, flat, fluted or quilled florets, regularly spreading or erect, the florets of each bloom being of one character. Klondike and Diana are good examples of this type.

Singles. — The single varieties may be of any size or form, but the florets, whether short and rigid, or long and drooping, should be arranged sufficiently close together to form a regular fringe. They may have one or two rows of ray-flowers as in Gertrude, or from three to five rows, as

in Miss Irene Cragg and Merstham Jewel. The center florets are always tubular and may be short, as in Mary Richardson, or elongated into somewhat anemone forms, as in Kathleen May.

Spidery, Plumed and Feathery. — Varieties of this section have small or medium-sized flowers of eccentric shapes, but more frequently of a light and graceful character. Some have thread-like petals, as in Golden Shower; others have broader florets. They may be erect, horizontal or drooping, and of various shapes and colors, such as King of the Plumes and Mrs. W. Wilkins.

All chrysanthemums may be further classified into early varieties, which usually flower before October 15; mid-season varieties, which flower from October 15 to November 10; and late flowering varieties, which bloom after November 10.

321. Classification as to types of plants. — Chrysanthemums may also be classified into various groups, according to their habit of growth. These are as follows:

Exhibition potted plants. — Specimen or exhibition plants of large size are sometimes grown in ten- or twelve-inch pots. Because of the extreme care required in growing and training, these plants are not grown to any extent except in large conservatories. They often bear several hundred flowers, and are trained into wonderfully symmetrical plants. Cuttings are taken early in November or December, and as soon as rooted, they are potted into two and one-quarter inch pots. They are then pinched and their training is begun. As soon as the soil is filled with feeding roots, they are re-potted and this is repeated until June, when they are in ten- or twelve-inch pots. They are almost constantly pinched until a very symmetrical foundation for the development of the shape of the

plant is secured. A wire form is placed about the plant, and every branch is trained into its desired position. This requires almost daily care. After they have become established in their flowering pots, they are fed frequently with liquid manure until the buds begin to show color.

Exhibition standard plants. — Standard chrysanthemum plants are propagated about the same time as the broader-headed specimen plants. The varieties which naturally have a tall habit of growth, like Dr. Enguehardt or Col. Appleton, are selected for this type of plant. The cuttings are not pinched, but when the stem has reached a height of three or four feet, the center is pinched out. Great care is taken to prevent the development of side buds along the lower part of the stem, and to form a bushy symmetrical head above. This gives the plant the typical standard shape.

Potted plants for general culture. — Chrysanthemums in five- or six-inch pots are very attractive when well grown. For this purpose, only those varieties which naturally form a compact, dwarf habit of growth are selected. They may be singles, anemones, pompons or the dwarfy varieties of the Japanese types. The cuttings are taken from May 15 to June 1. They are potted as soon as rooted and kept growing constantly. Care should be taken to have them retain their foliage well down to the base of the plant. They should begin to bud by the first of September. They should be frequently re-potted to furnish sufficient room for growth. The plants will need support, and this should be as light and inconspicuous as possible. Plants grown as described are excellent for commercial purposes.

Potted plants trained to a single stem. — Cut-flowers which are desired for exhibition purposes are, many times,

grown in six- or eight-inch pots. It is considered that they may be given better care than when grown in beds or benches. They may also be moved from place to place, and thus given different temperatures as their growth requires it. They may be fed more easily and with less risk of over-feeding. Cuttings for single-stemmed plants are usually taken in March and potted and grown the same as other types of plants, except that they are not pinched unless they bud too early. Much care is taken to keep all lateral shoots pinched back, and to develop a strong plant with a straight, succulent stem. It is desirable to retain all the basal roots possible, and to feed the plant judiciously.

Single-stemmed plants in benches and beds. — When grown in benches or beds, exhibition flowers or those grown to a single stem are propagated at the same time as those grown in pots. When they have become well established in three-inch pots, they are planted in the benches. The same general care is given as is given the potted plants.

Plants for commercial cut-flowers. — For commercial use, medium-sized flowers are the most in demand. Three or four flowers, therefore, are usually allowed to develop on a plant.

322. Propagation for commercial cut-flowers. — For commercial purposes, cuttings are usually taken in March. As soon as they are rooted, they are potted in two and one-quarter-inch pots. It is very essential that the stock plants from which cuttings are taken be given careful attention so that strong, healthy, close-jointed, basal shoots are produced. As soon as the old plants are through flowering, they are cut down. The plants are then lifted from the benches and planted in fresh soil,

close together, in flats. They are then placed in a light house where the temperature averages about 40° until such a time as the cuttings are to be taken. This prevents disease and keeps insects in check. The stock plants should be fumigated frequently with cyanide of potassium, to keep the aphids in check.

The cuttings should be two or three inches long. The stem should be thick and firm, and have several joints. Plants from spindling cuttings are rarely vigorous. Cuttings should form a good root system in three weeks, and if this is not accomplished, they are worthless. A plant, stunted in growth in the cutting bench, seldom recovers. A bottom heat of 60° and a house temperature of 50° suits them well.

323. Potting chrysanthemum cuttings.—As soon as cuttings have roots about half an inch long, they should be potted in two and one-quarter- or two and one-half-inch pots. It is a great mistake to allow cuttings to remain in the sand after they begin to grow. There is no nourishment in the sand; it simply acts as a medium for holding the moisture until the cuttings can push out roots.

The soil for the first potting should not be made too rich. A good loam, with a small percentage of rotten manure, is all that is needed. When the plants are established in this soil and have begun to grow nicely, all the air possible should be admitted to the house night and day.

The treatment of the cuttings from the time they are rooted until it is time to plant them in the bed or bench, has been given previously.

324. Soil.—The best soil for chrysanthemums is a good, fibrous loam, porous enough to allow ready drainage. Heavier, more clayey soil may be used, but not with as good success. It is not, however, so much the character

of the soil as it is the food elements present in it, which determine the growth of the plant. The soil should be rather rich, as chrysanthemums are heavy feeders. The best soil is made by cutting sods and composting them with fresh cow manure; use one part cow manure to four parts sod. Compost this in the fall, then cut it down in the spring, at which time wood ashes and other fertilizers may be added; bone meal is very commonly used. This may be applied in the proportion of about one pint bone meal to a bushel of soil.

325. Benches. — Chrysanthemums for commercial purposes are usually grown in benches. Raised benches are best, even if raised only one foot above the ground. They drain more readily and quickly than do solid beds. However, solid beds may be used; in which case, good drainage should be provided. Benches should not be over four feet wide; the center row can then be reached from both sides, and the plants are sure of good air circulation. This is not true of plants on wider benches.

326. Filling the benches. — Benches for chrysanthemums need not be over five inches deep. With a rich soil, supplemented with liquid feeding from time to time, four inches of soil is sufficient. Some growers prefer to firm the soil thoroughly before planting. This is done with a heavy mallet or a brick. The soil is then leveled and is ready for planting. Others prefer to pack the soil just after the plants have become established and then to firm it. If the soil is firmed, the plants will be shorter jointed than in a light, loose soil. If a naturally heavy soil is used, and is then firmed, the plants may have difficulty in becoming established and in making good growth.

327. Planting. — Plant in rows ten inches apart, and have nine- or ten-inch spaces between the plants. In a

bench four feet wide, this would mean five rows. Some of the varieties which have small leaves may be planted more closely, while stronger growing forms should be given more space. Many varieties when grown to single stems may be planted nine inches between rows, and six inches apart in the row. Where two or more flowers are grown to a plant, they should be put at least nine inches by ten inches apart. The benches should be marked off carefully to get the rows straight. This is necessary on account of the wires which are later used for supports. In transplanting it is very essential that the plant should not be set too deeply, but may be a little deeper than it was in the pot, and the ball of earth should be broken slightly. To aid in giving the plants sufficient water, a depression in the soil around each plant should be made. If the plants are being grown for commercial purposes, they should be set in the benches by the end of June.

328. Watering. — The first time that the plants are watered in the benches, it is advisable to water only around each individual plant. After they are well established, the entire bed may be watered with safety.

Moisture conditions of the soil should be kept as uniform as possible. Drying out of the soil checks the growth and causes the wood to harden, a condition which is very undesirable in chrysanthemums. Too much soil water causes the leaves to turn yellow and the plants to look sickly. Some growers prefer to water altogether from overhead, until the flowers begin to expand. This helps to hold insects in check. Others think it is better to water the surface of the soil.

329. Syringing. — The plants should be syringed every bright day, often two or three times a day during the sum-

mer, but the foliage should be dry by night. In syringing, it is not necessary to apply enough water to wet the soil, but simply to moisten the foliage.

330. Feeding. — In properly prepared soil, the plants will require feeding in six or eight weeks. The first feeding should be a mulch of cow or sheep manure; if cow manure is used, apply one-half to one inch thick; if sheep manure is used, apply only half as much. The plant food in this mulch becomes gradually available, and is carried into the soil by each successive watering. This mulch also assists in holding moisture in the soil. About a month after applying the mulch, the length of time depending in a large degree upon the condition of the plants, it is time to begin feeding with liquid manures. If cow manure is used, take one-half bushel of manure to one barrel of water; if sheep manure is used, this should be in the proportion of one-half bushel to one and one-half barrels. Chemical fertilizers may also be used. E. D. Smith, of Adrian, Michigan, recommends four parts ammonium phosphate and six parts of potassium nitrate, applied at the rate of one ounce of the mixture to ten gallons of water.

The frequency of the application depends upon the condition of the plants. Once a week is not too often if the plants are growing well and the fertilizer is not too strong. Feed until the buds begin to show color. Feeding later than this causes softness of the flowers.

331. Topping. — If plants are to be grown for two flowers, they should be cut back when six or eight inches high, to make them send out side shoots. Later, select the two strongest and remove all side shoots, to throw the strength into the two selected. If grown for one flower to a stem, they should grow without topping.

In both cases, remove all lateral growths as soon as they are large enough to rub off. Continue to do this throughout the season.

332. Tying. — When the plants begin to grow, it is necessary that they should have support. Sometimes only stakes are used, and the plants are tied to these; or a modification of this is to secure the stakes to a wire strung above the row. The most common method used is to stretch a wire above each row and another wire at the base of the plants, and then run coarse twine between them. As many tyings as are necessary are made to this twine; use white cotton twine or raffia for this purpose. Do not tie too tightly, but allow for an increase in the size of the stem.

333. Disbudding. — Disbudding is one of the most important points to be considered in growing chrysanthemums. For large blooms, all buds except one are removed from the stem, the strength of the plant thus being thrown into one flower.

There are two types of buds, the "crown" and the "terminal." Crown buds are those which are formed early, and are surrounded by vegetative shoots or leaf buds, but not flower buds. The earliest crown bud, if removed, may be followed by second or third crown buds. Terminal buds are those which terminate the shoot and are surrounded by other buds and not vegetative shoots. When terminal buds are produced, they should be retained, as no other buds are formed. Ordinarily, terminal buds develop into the most satisfactory commercial blooms.

334. Outdoor culture of chrysanthemums. — The group of hardy chrysanthemums is especially important and is attracting more and more attention each year. They are

highly desirable for the southern states, where early frosts are the exception. They make excellent garden-flowers, however, even as far north as central New York, provided care is taken to select early-flowering varieties.

335. Propagation. — There is a mistaken idea that when once planted, hardy chrysanthemums will flower indefinitely. This they will do to a certain extent, but the blooms are by no means as desirable or attractive as when propagated each year. Chrysanthemums are rank feeders and quickly exhaust the soil. Consequently, the growth becomes weaker, and the flowers smaller, with shorter stems. That they are hardy in most sections, and will come up and grow each spring, is true, but the best way to produce the greatest quantity of flowers is to take cuttings from the plants every spring.

As soon as the days have become warm enough to start the plants into growth, and the shoots have become two or three inches long, they should be removed, some of the foliage cut off and the end squarely and smoothly cut. These cuttings are placed in boxes of clear sand or in sandy soil, and carefully watered. In a few days they will have become well rooted.

336. Planting outdoors. — When well established in soil, the young plants are planted in the herbaceous border in fairly rich soil. The plants are pinched back several times during the summer, to prevent spindling and to make them stocky and bushy. This pinching should not be done after August 1. They should be cultivated and hoed frequently during the summer to prevent drying out of the soil, and to keep the weeds in check.

337. Staking. — By August 15, chrysanthemums should be staked and carefully tied up, to insure long, straight flower-stems. They should begin to flower about Sep-

tember 1, and from the middle of September until after the hard frosts, the plants should be a mass of bloom.

338. Prolonging the season of bloom. — If one wishes to prolong the flowering season, the plants may be lifted, watered thoroughly and placed in a protected spot, possibly in the windows of the living room, where they will continue to bloom a long time.

339. Insects and diseases. — Plants propagated each year show a greater resistance to disease, and are less liable to be attacked by mildew than are those grown from the same roots and in the same soil year after year. If hardy chrysanthemums do show a tendency to be attacked by mildew, as is possible in wet seasons, they should frequently be dusted with sulfur. Plants grown yearly from cuttings are also less likely to be attacked by the green fly or other forms of aphids.

340. Watering, feeding and disbudding. — These plants like a liberal amount of water and a well-drained soil. If the foliage is sprayed thoroughly with a garden hose every bright morning, the growth will be more luxuriant. An occasional feeding of liquid manure is also acceptable. If the best quality of blooms is to be obtained, the plants should be staked, and the loose shoots tied up from time to time. If large, individual flowers are desired, rather than a mass of bloom, considerable attention should be paid to disbudding. As soon as clusters of buds are well formed, the side buds are removed, leaving only the center buds to develop.

CHAPTER XIV

CUT-FLOWER CROPS (CONTINUED) — VIOLETS, ORCHIDS, SWEET PEAS, MIGNONETTE, SNAPDRAGONS, WALLFLOWERS, LUPINES, TEN-WEEKS' STOCK AND FREESIAS

VIOLETS

THE violet is not the popular flower it was a few years ago, having been somewhat displaced by the many species now grown. However, their pleasing and attractive color and fragrance make them much in demand. Many florists grow only violets, and this specialization has had a marked influence on the improvement of the flowers.

341. Botanical classification. — Order, *Violaceæ*; genus *Viola* (classical name); species, *odorata*.

342. Present-day varieties:

Double.

Marie Louise

Lady Hume Campbell.

Single:

California

Princess of Wales
(Princess de Galles)

Other double varieties are: Farquahar, Imperial, Neapolitan, De Parme, Swanley's White, Madam Millet (pink). Other single varieties are Welsiana, Luxonne, Dorsett.

343. Propagation. — Violets are propagated in several ways. Among them are division of the crown or parent plant after the flowering season is over; taking rooted

cuttings or offsets from the parent plants during February or March; and selecting healthy, terminal shoots from the parent plants between the middle of January and the middle of March, and rooting them in the propagating benches the same as other plants are propagated.

In most cases, the last method is the most satisfactory, for there is less danger from disease in the resulting plants. If the cuttings have formed air roots, they are trimmed off as the cuttings are prepared for the propagating bench. The sand used must be moderately coarse and entirely free from decaying foliage or organic matter of any kind. The same sand should be used but once.

Many growers follow the practice of using a combination of the last two methods of propagation. The parent plants are gone over from time to time, and material for propagating is selected. If there are young, well-developed shoots on which sufficient roots have not formed to assimilate food, such may be prepared for the propagating bench. Those having strong, clean, white roots are placed directly in boxes of fresh soil. The soil should be sifted through a medium fine mesh, and should contain but little manure. Ordinary flats may be used, and the rooted cuttings are placed about two and one-half inches apart. In setting, the plants should be firmly placed in the soil, watered carefully and shaded for a few days. When they have become established in the soil, they may be moved outside into a cold frame, but they usually receive better attention if placed in a cool greenhouse. Wherever placed, the plants should be given abundant ventilation, and the glass should be partially shaded. In selecting the flats, care should be taken to have large holes in the bottom to insure perfect drainage, for violet plants are especially liable to be injured by too moist a soil.

The method of propagating violets by division is extensively followed, although there are objections to it. In dividing the crown year after year, diseases which may be affecting the root tissue are liable to be carried from one year to the next. If the practice is continued, the plants have a tendency to become weak and not resistant to disease. Weak plants produce inferior blooms, quite unlike those produced on plants propagated by cuttings of fresh stock. Still another objection is that propagation by division must be done late in the season, after the blooming period is over. The parent plants are weakened by the abundance of bloom produced during the season, and the weather conditions in April and May are not ideal for the propagation of strong plants.

344. Soil.—Violets usually do well in any well-nourished soil. The best results, however, are obtained from a rather heavy, sandy loam. It should be well drained, yet capable of retaining moisture at all times. Fresh soil should be used each year, and it is usually prepared by the compost method as described in Chapter X.

345. Methods of culture.—It is now believed that violets need as ideal conditions for growth as those required for other crops. Earlier in the history of violet culture it was thought that they might be grown in any house and under any conditions. Up-to-date American florists have excellent violet houses.

The various ways in which violets are grown are field and house culture; house culture; frame culture with artificial heat; frame culture without artificial heat and pot culture.

346. Field and house culture.—In most cases, violets are grown in the field a part of the year. As early in the spring as the ground can be worked, the young plants

which have been in the cold frame are planted directly in the field. Here they are given careful attention during the summer, quite similar to the field culture of carnations.

347. Season of year for planting in greenhouses. — In the fall, the violets are lifted with a ball of earth and transplanted into beds or benches in the houses where they are to bloom during the winter. Most growers believe that it is better not to house the violets much before the middle of October, thus avoiding high temperatures, such as may occur in houses in the early fall.

348. Solid beds or raised benches. — The larger number of growers prefer solid beds to raised benches, as in them it is easier to maintain a cool, moist soil, such as the violet naturally likes.

349. Planting violets. — The distance for planting varies with different varieties. As a rule, double violets are planted eight or nine inches apart in rows ten inches apart; and single ones are planted about twelve inches apart, in rows twelve inches apart. Close planting should be avoided, as it is likely to cause many diseases.

350. Care of plants. — When planting, all runners and decayed leaves should be removed, and in a week or two the plants should be looked over and again any dead leaves or weeds removed, and the soil stirred. The plants should not be placed too deeply in the soil, for if the crown is covered, decay quite frequently occurs. After the plants are in place, they should be thoroughly watered, and given all the air possible. It is well to cover the glass with whitewash or something similar, but as soon as the plants are well established, all shade should be removed. The first watering is all the plants should have until they become thoroughly established in the soil.

351. Temperature requirements. — The temperature

requirements vary with the variety grown. As a rule, single varieties flower best in a temperature of from 45° to 50° with a day temperature of from 60° to 65°. Double violets should be kept cooler, or at a temperature of about 40° to 45° at night. It should be remembered that the violet is a crop which demands a low temperature, and that high temperatures will produce an overgrowth of leaves and inferior flowers.

352. Ventilation and watering. — In order to secure the best results, violets should have an abundance of fresh air, but never be chilled, also an abundance of water, for it requires good judgment to keep the soil in the proper condition. The soil should be moist at all times, but there should never be enough water so that it will remain saturated for any length of time.

353. House culture. — Some growers never plant violets in the field. As soon as the plants are well established in flats, they are placed in coldframes out of doors. The advantage claimed is that the plants receive no check from transplanting in the fall. By the middle of May they are planted in permanent beds in greenhouses, which should have abundant ventilation and be heavily shaded during the summer months. If grown in portable sash houses, the sash is removed after the plants have become well established, and is left off until quite late in the fall. The plants are then cultivated throughout the winter the same as if they were grown out of doors during the summer.

354. Frame culture with artificial heat. — Violets may be grown in frames out of doors if provision can be made for ventilation. This is extremely difficult, however, during cold weather. A deep frame may be built along the south side of a dwelling house, and heating pipes

connected with the house furnace may enter this through the underpinning of the house. The soil is prepared the same as for greenhouse culture, and the plants grown in the frame through the summer and fall. As soon as cold nights come, the sashes are put on the frame and heat furnished from the furnace. The heat must not be too intense or the plants will be smothered. The sashes should be removed every bright day, and no artificial heat given. Days when the temperature fails to go above 35°, the sashes should not be removed. On other days, ventilation should be given as soon as the atmosphere has warmed sufficiently.

Snow should be kept clear from the sashes, and if a strong, vigorous growth is in every way encouraged, violets may be had in flower during the greater part of the year.

South of New York City, violets are successfully grown in frames by using decomposing stable manure as a medium of heat. The frames are constructed the same as those described in Chapter IV and a second frame is placed about one foot outside of the original frame. This space is filled with decaying stable manure and firmly compacted. It should generate heat enough to prevent the plants from freezing. Mats and shutters should be provided and the frames covered every cold night. The same directions for ventilation should be followed as those given for the frame heated from the furnace.

355. Frame culture without heat (Fig. 28). — Violets may be grown in frames without artificial heat. They will not flower to any extent during the winter months, but remain dormant, and flower early in the spring, producing a crop for the florist, after the violets in the greenhouses are through blooming. The plants are placed in the frames in the early fall, and the ground allowed to

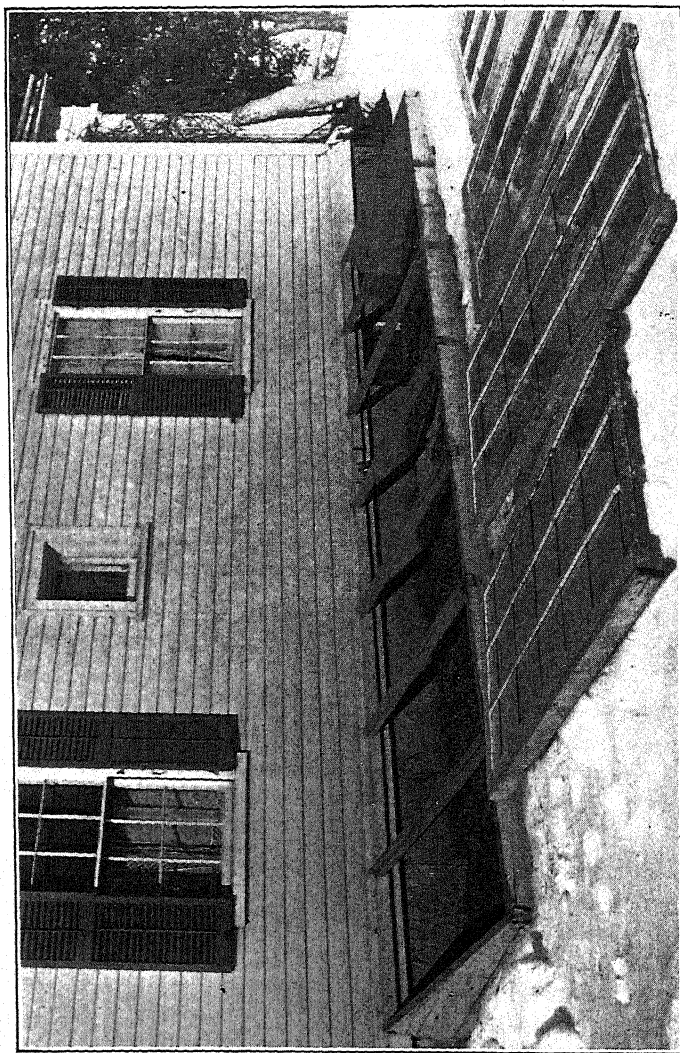


FIG. 28.—A frame for violets on the south side of a dwelling.

freeze solid. The frames are then covered with boards so that the plants will remain frozen during the winter. By the middle of February, mats and glass shutters should be used, and the beds covered on cold nights. As soon as the plants start into growth, they should be given ventilation every bright day, and should not again be allowed to freeze. The plants should begin to flower by the middle of April, and their season of bloom should continue until the first of June.

356. Marketing. — Marketing is one of the most important factors connected with commercial violet-growing. It is exceedingly important that the greenhouse be located comparatively near the market, for the violet soon loses its delicate perfume, for which it is specially prized. The best market for violets is one which can be reached without delay after the flowers are picked. The flowers are usually picked in the early morning and taken to market immediately. Violets are very susceptible to diseases, and they are described in Chapter XI.

ORCHIDS

357. Botanical classification. — Order, Orchidaceæ; genera, over three hundred; species, about ten thousand. The word orchid is derived from a Greek word and refers to the gland-like character of the pseudobulbs. The family is a large and important one from the florists' point of view. As a rule, the plants are unattractive, but the unusual shapes of the flowers, their brilliant coloring and comparative scarcity make them much in demand. The most important commercial genera are :

Calanthe	Cypripedium	Læliocattleya	Oncidium
Cattleya	Dendrobium	Lycaste	Phalænopsis
Cœlogyne	Lælia	Odontoglossum	Vanda

358. Habitat. — The family is widely distributed, but the principal orchids come from Mexico, Central and Northern South America, the Philippines, China and Japan. A few are natives of the temperate zones, and are all terrestrial.

359. Habit of growth. — The habit of growth of orchid plants is almost as varied as the flowers themselves. They are divided into three groups: saprophytes, epiphytes and terrestrial. The first form has no distinct root system, but the underground stem or rhizome consists of a twisted and coiled mass. This absorbs food from the organic matter in the soil or from the roots of other plants. They prepare little or no food of their own, and are mostly destitute of coloring matter. None is cultivated; therefore they are of little interest to the florist. Epiphytes inhabit the branches or trunks of trees and even barren rocks in exposed locations. They are native in tropical countries, where a part of the year is unfavorable for growth. Because of their habit of growth, many orchids have a well-developed pseudobulb, which functions as a storage place for reserve food. Practically all of the species are imported. They are often lacking in graceful foliage, and in some species the plants are entirely devoid of leaves at the flowering season. This is true of *Calanthe*. In *Cœlogyne* and *Miltonia*, the pseudobulbs are less conspicuous, and the foliage is retained during the flowering season, making a more attractive plant. The terrestrial orchids include some of the largest species. They are widely distributed throughout the temperate and subtropical countries. In some species, the foliage is pleasing even when not in flower.

360. Popularity of orchids. — The orchid is rapidly becoming more and more popular. People are coming to

know it better and are demanding it. A few years ago it was rather unusual to see an orchid worn as a corsage decoration, but at the present time these flowers are frequently seen on the street and at public functions. They are also used extensively for table and hall decorations. The larger part of the tropical orchids grow on trees.

361. Preparation of orchids for shipping. — It is necessary to dry out, before shipping, the large amount of water stored in the pseudobulb. The plants are gathered and spread in the air for a period, that the excess of moisture may be drawn out of them. They are then packed and shipped to this country.

362. Treatment of freshly imported plants. — As soon as received, they should be spread in a moist atmosphere to absorb gradually the moisture which they lost before shipment. In this way, the growth resumes its normal activity. Most orchids are native in a country where there is a dry season and a rainy season. During the dry season the orchids are in a state of partial rest, and this is the best time for shipment.

363. Potting. — After they have absorbed sufficient moisture so that growth commences, they should be potted. The medium for use in potting varies with different species, but for most of the epiphytal orchids, it consists largely of osmundine (osmunda fiber). This fiber is the roots of ferns, and is almost entirely lacking in organic matter. It, however, holds moisture and allows air to enter freely about the roots, so that a healthy growth is insured. The orchids are potted very firmly in this material, and some sphagnum moss is put over the top to increase the moisture capacity of the medium in which the roots are to grow.

364. Propagation by seeds. — Up to the present time, comparatively few orchids have been propagated in this country from seeds. This has been because the length of time necessary to produce a flowering plant is a long one. Many species will not flower until they are seven or eight years old, and some even fifteen or twenty years. As the plants are becoming more and more scarce in their native habitats, and very difficult to collect, more orchids are now being propagated from seeds in this country. After the flowering season, it takes the seed-pods from nine to fifteen months to mature.

The seeds are minute and therefore it is necessary to take great care in sowing. As the seed germinates slowly, and the plantlets are very small, it is necessary that the medium in which the seeds are sown be of such a character that it will not become sour during the germinating process.

Usually shallow pans are filled about two-thirds full of clean, broken pieces of pots, and the remainder with coarse fern roots. Sometimes the seeds are sown directly in this fern fiber, and sometimes on Turkish toweling which is spread over the fiber. The pans are then set into the propagating case where the atmosphere is kept moist. It is necessary to use the greatest precaution in watering, and the water should be given in a fine mist-like spray. An atomizer is excellent for this purpose. The amount of water should be gauged very carefully and this requires excellent judgment. In bright warm weather, the seedlings will require damping twice a day, but in dull, cool weather, probably once or twice a week will be sufficient.

After the first, or the seed-leaf, has made its appearance, the plants should be transferred to a separate pot. The size of the pots will depend on the vigor of the plant, but

they should be much smaller than for most other species. As the plants develop, they need to be re-potted from year to year as the soil medium is filled with roots.

365. Temperature requirements. — The temperature required for orchids varies with different species and varieties, and will be considered under the cultural notes in the different genera

366. *Calanthe*, botanical classification. — (Name from Greek for beautiful flower); tribe, *Vanda*; species, *vestita*. *Veitchii* is a hybrid between *vestita* and *rosea*. It is often given a species rank. This is the best *calanthe* for cut-flower purposes. There are many other named hybrids and varieties.

367. *Calanthe*, botanical characters — *Calanthes* produce strong pseudobulbs, from the tip of which a broad, plaited leaf develops. After the growing season is terminated, the leaves drop and the flower buds soon appear. This is usually about December first. A long peduncle is formed and the basal flowers begin to open about January first. The flower-cluster develops slowly, requiring nearly six weeks. The flowers are mostly white or rose colored.

Habitat. — India.

368. Culture of *calanthe* — *Calanthes* are among the easiest of culture. The soil should contain about one-third each of chopped sod, with the fine soil removed, chopped live sphagnum and leaf-mold, a little charcoal being added to sweeten it. One-third of pot space should be devoted to clean drainage, with a layer of sphagnum. Distribute the roots evenly and work the compost into them firmly, leaving the surface convex and a little below the rim of the pot. The convex surface gives the base of the pseudobulb a chance to dry out frequently, thus avoiding black-rot, which is very troublesome in this species.

In the care of *Calanthe Veitchii*, *C. vestita*, and the crosses between these, they are generally potted every year. After the flowering season is over, the pots with the dormant bulbs are laid on the side in a dry, warm place, and no water given. About March first they are shaken out of the pots and the bulbs potted singly or several in a pot. The old roots are useless, and the bulbs must then make new roots. The bulbs should be potted only deeply enough to keep them firm.

The best time to re-pot is about April first, just before the growing season begins. When calanthes are propagated, they require a night temperature in winter of about 55°, and a day temperature of from 65° to 70°. They should have an abundance of water during the growing period, but when the leaves begin to drop, they should be given partial water until flowers begin to form. During the flowering season, just enough water should be given to keep the flowers from wilting. When the flowers are gone, complete rest is needed for four or six weeks.

369. Cattleya, botanical classification. — (Named after William Cattley, an early English naturalist.) Tribe, Epidendrææ; species, many. The more important species are: *labiata*; *Skinneri*; *Bourningeana*; *Forbesii*; *amethystina*; *Loddigesii*; *Loddigesii* var. *Harrisonia*. *Cattleya labiata* is the most common species. It is exceedingly variable, and has many varieties. They are usually given species names in commercial catalogues. Among these varieties are: *gigas*, *Mendelii*, *Gaskelliana*, *Mossia*, *Triana*, *Percivaliana*, *Warneri*, *speciosissima* (*Luddemanniana*), *Schræderæ*, *chrysotoxa* (Fig. 29).

370. Cattleya, botanical characters. — Epiphytes. Plants with distinct pseudobulbs, each with from one to three leathery leaf blades. The flowers are usually ter-

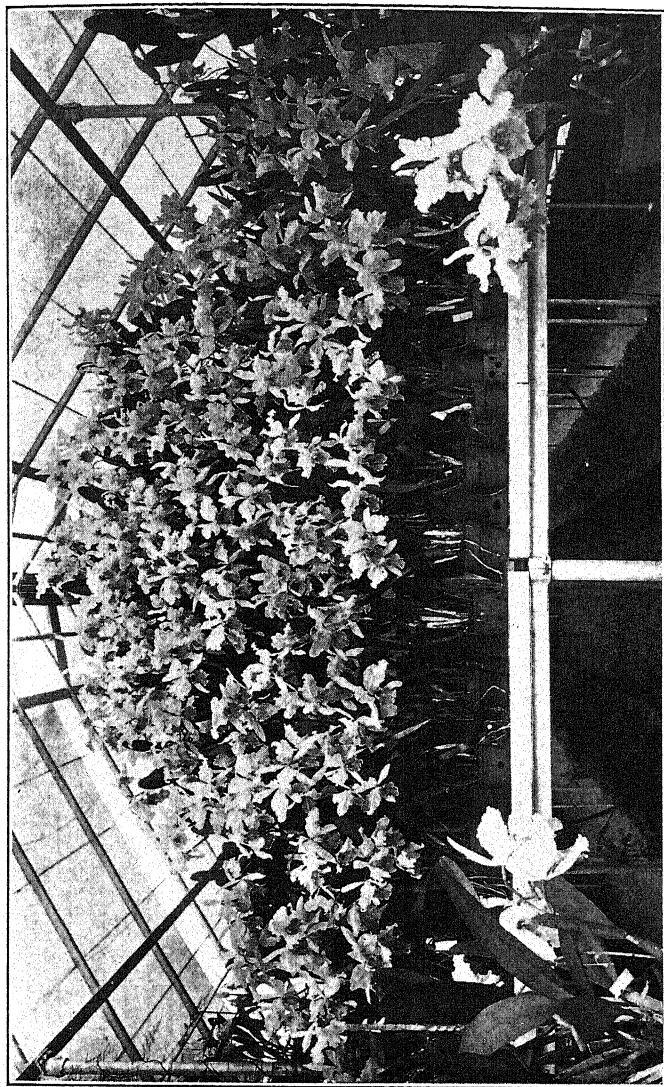


FIG. 29.—A house of cattleyas.

minal, large, showy and fleshy. The petals and sepals are nearly equal or the petals larger; labellum fluted, usually trilobed, inclosing a club-shaped column. No other genera of orchids have more intense coloration. They are often delicately fragrant. These vary much in color, but are usually shades of lavender or purple with the labellum variously striped and marked. The number of flowers on a peduncle varies with the species, from three to thirty. They flower at different seasons, therefore, to have cattleyas constantly in flower, one must carry a large stock.

Cattleya labiata (type) flowers in October and November; *Bowringiana* in October and November; *Percivaliana* in December; *Trianae* in January, February and March; *Schroederæ* in March and April; *Mossii* in April and May; *Mendelii* in April and May; *Warneri* in May and June; *gigas* in June and July; *chrysotoxa* in June and July; *Gaskelliana* in June, July and August; and *Loddigesii* var. *Harrisoniæ* in September and October.

Cattleyas are collected and imported probably in larger numbers than any other genera. They are popular with the commercial florist because they are large, splendidly colored, have good keeping qualities and are easily grown.

Habitat. — Tropical America.

371. Culture of cattleyas. — A temperature of about 55° or 60° at night suits most species of cattleya. They are grown in baskets, on boards, or in pots and pans. They should, however, have excellent drainage facilities, and are, therefore, potted in osmundine (osmunda fiber). A little live sphagnum moss may be placed over the top, but this is not absolutely necessary, for if the peat used is fairly soft, the plants will grow just as well without the moss. Where cattleyas are grown commercially for

cut-flowers, it is found that by covering with moss, a great many slugs are harbored, and consequently many flowers are eaten by them.

Cattleyas require frequent syringing during their growing season. The hose should be used freely, watering overhead so as to saturate the sphagnum moss. After flowering has ceased and the pseudobulb is mature, the resting season begins. They are then partly dormant. Enough water should be given to prevent the pseudobulb from shriveling. This resting causes new eyes to develop slowly and these produce new flowering pseudobulbs. As soon as these new breaks start, more moisture should be given, and the new roots encouraged to grow. If the boards, baskets or pots are occasionally taken from the sash-bars and dipped, the growth will be more satisfactory. It is believed that no cattleya should be more than three feet from the glass. When grown in pots, they are sometimes set on a staging which is near the glass. This should be kept clean and frequently whitewashed.

372. Cœlogyne, botanical classification. — (Name from Greek, meaning hollow pistil), tribe Epidendreæ; species. the most important commercial species is *cristata*; others are *asperata*; *Massangeana*; *pandurata*; *Dayana*.

373. Cœlogyne, botanical characters. — Epiphytes. Cœlogyne are free-flowering species of the easiest culture. The pseudobulbs are numerous, nearly cylindrical, or globular, especially so in *C. cristata*. They are terminated during the growing season by one or two long lanceolate leaves. The flowers are borne in a loose raceme which springs from the base of the pseudobulb. The individual flowers are rather large, pure white, except the labellum which has fine, bright yellow blotches.

Habitat. — Tropical Asia.

374. Culture of cœlogyne. — The culture of cœlogynes is about the same as for the cattleyas. They are best grown in pots. They flower from about January first until March.

After flowering they should be re-potted, being careful to get one or two leading growths in each pot, and kept in a cool, moist, shaded place until roots start to grow. They are then given a moderate amount of water, and are kept in a cool house until about the first of September, when they may be given a night temperature of 55°. Weak manure water may be applied once a week during the growing season.

375. Cypripedium, botanical classification. — (Name from the Greek *Cypriis* — Venus, and *podion* — slipper.) Lady's Slipper, Moccasin Flower.

Species, many. There is a tendency among tropical cypripediums to hybridize, so that much confusion in nomenclature has arisen. The principal commercial species are as follows. *barbatum* (June and July), many varieties; *villosum* var. *Boxalli* (January and February); *caudatum* (Selenipedium) (June and July); *Harrisianum* (January to March); *insigne* (October to January); *javanicum* (May and June); *venustum* (January to March); *Spicerianum* (October to December); *japonicum*.

The hardy species are: *acale*; *pubescens*; *spectabile*; *candidum*; *arietinum*.

376. Cypripedium, botanical characters. — Cypripediums comprise a group of mostly terrestrial orchids with a few epiphytes. They have a fleshy root system, with several somewhat succulent, basal leaves. The flower develops from the terminal shoot of each plant. This flower is less striking in its coloration than in many genera of orchids. The floral segments are fleshy, the

upper sepal usually larger than the petals, and the two lower sepals usually united in one. The petals are spreading, often colored like the sepals. The labellum becomes a large inflated sac. The essential organs are variously modified so they differ in structure from other orchids.

Commercially, cypripediums and selenipediums are the same. Botanically they are different. Selenipediums are South American cypripediums. Technically, the genus is separated from cypripedium by its having a three-celled ovary, flowers several in a panicle, and it is a more robust grower.

Habitat. — North and South America, Europe, Asia, Malay Archipelago. None from Africa or Australia.

377. Culture of cypripediums. — Cypripediums are among the easiest of orchids to cultivate. They require no resting period, therefore they should be kept moist throughout the year. They should be grown in a house which registers from 60° to 65° at night in winter, and about 70° day temperature. On the approach of spring, the temperature should be raised a little, and in the fall decreased. About the middle of February, the glass should be given a light shading, and about the last of May this should be made heavier, then gradually removed during the fall, so that in the winter they may have full sunlight. The larger number are terrestrial and should be potted and grown as advised for cœlogyne. The plants are evergreen.

The hardy varieties grow best under shrubs or in shaded rockeries. They also force well. The soil should be an open and porous mixture of about equal parts chopped sod and leaf mold. An eight- or ten-inch pot with at least two inches of drainage in the bottom will hold several crowns which are planted about two inches be-

low the surface of the soil. After a thorough watering they should be stored in a coldframe and protected with boughs. By the first of February, they may be removed to a cool house, where they remain for a week, and then placed in a carnation temperature and watered sparingly until growth starts. They flower better in partial shade.

378. Dendrobium, botanical classification. — (Name from Greek — *tree*, and *life*, — referring to their epiphytic habit); species, many; the most common commercial species being:

densiflorum (March and April), yellow with orange-yellow labellum;

Devonianum (April and May), petals and sepals white with the upper part purple; labellum white with a deep purple blotch in throat;

Findlayanum (March to June), petals and sepals pale pink; labellum yellow margined with white;

infundibulum (May to August), petals and sepals white; labellum large with an orange-yellow blotch in throat;

nobile (May to July), petals and sepals white with pink tips; labellum white with a blotch of purple at the tip; throat dark crimson;

thyrsiflorum (May and June), sepals and petals white; labellum yellow;

Wurdnanum (February to April), petals and sepals white; labellum yellow, white on margin with a narrow blotch in throat.

379. Dendrobium, botanical characters. — Epiphytes. Dendrobiums are orchids having very variable characters in the pseudobulbs, some being narrow and several feet long, others very small and thin. The flowers are borne in racemes, in fasciculate clusters or solitary. They embrace a wide range of colors, white tipped with purple, yellow or pink. The leaves are thick and leathery. The pseudobulbs are, for the most part, smaller at the base than at the tip, and distinctly jointed.

Habitat. — Australia, tropical China, Japan, India and the Philippine Islands.

380. Culture of dendrobiums. — Dendrobiums grow better in comparatively small pots or baskets and are often grown on blocks. They require the same soil conditions as do cattleyas, but differ from them in their moisture requirements and their flowering habit. During the season of growth, they should be given abundant moisture and a night temperature of about 65°. When growth is completed, the temperature should be lowered about 10°, and water partly withheld, to ripen the wood before flowers are produced. When buds form, only enough water should be given to keep the pseudobulbs plump. When in flower, they are often nearly destitute of leaves. After the flowering season, growth should begin at once.

381. Lælia, botanical classification. — (Derivation of name uncertain.) There are about thirty species of Lælia. They are divided into four groups based on the characters of the pseudobulb and the flower-cluster.

Group 1. The pseudobulbs are rounded, pear-shaped (pyriform), or ovate; they form medium sized plants. The flower-scape is slender, erect, nodding or subhorizontal, bearing at its end from one to twenty flowers

Lælia anceps (November to January), sepals and petals rosy, lip deep purple;

Lælia albida (November to June), white or pale pink, veined with yellow;

Lælia autumnalis (November to January), flowers purple, lip pink and white with yellow center;

Lælia flava (February to March), clear yellow;

Group 2. The pseudobulbs are short, cylindrical and stem-like. They are swollen at the joint and sheathed with bracts. They have a dwarf habit of growth, and bear one to two very large flowers on short stems. The leaves are leathery and about six inches long.

Læha Jongheana (February and March), amethyst, labellum white with seven yellow ridges in throat.

Group 3 The pseudobulbs are a foot or more long, oblong or club-shaped, tapering below to a sheathed and jointed stalk. This group contains the largest and most showy *Læhas*. They form robust, bushy plants. The flower-stems are long, bearing from two to seven flowers.

Læha Digbyana (Brassavola) (July and August), cream-white flowers, lip streaked with purple and beautifully fringed;

Læha crispa (June to August), petals and sepals white with pale purple at base, margins very finely crisped and wavy; lip white, streaked with purple-yellow at base,

Læha purpurata (May and June), flowers very large, white, lip purple-crimson;

Læha superbiens (January and February), a very large species; petals and sepals lilac-purple; lip yellow at base; crimson-purple on margins;

Læha grandis (March and April), a species with erect peduncle, bearing from three to five flowers, which are four inches across. The petals are broader than the sepals, and are tawny yellow in color, the lip is tube-shaped, white, veined with purple;

Group 4. The pseudobulbs are slender, reed-like and tufted. This group includes a few species with bright scarlet or orange flowers. The flower stems are from six to twenty inches long. *Læha monophylla* and *cinnabarina* are the principal species.

382. *Lælia*, botanical characters.—*Lælias* resemble cattleyas closely, varying only by the presence of eight pollen masses instead of four, and in minor floral differences.

Habitat.—Mexico, Guatemala, southern Brazil, one from Jamaica.

383. Culture of *lælias*.—Group 3, which resembles more nearly the cattleyas, should have the warmest temperature. A warm corner of the cattleya house would suit them best.

Group 2 should have a cooler temperature. They also

require more shade and moisture. They have comparatively little substance in the pseudobulb, and require, therefore, large amounts of atmospheric moisture. They have a very short resting period.

The remainder of the *lælias* require a sunny location at all times, with an abundance of overhead watering during their period of growth. After flowering, they should have a severe resting period, keeping them inactive as long as possible. The first group should be planted in rather large baskets; the second in comparatively small pots; and the last grow best in baskets or on boards.

384. *Læliocattleya*. — *Læliocattleya* is a generic name given to many hybrids between the *lælia* and *cattleya*. The cultivation of these resembles the *cattleyas*, but there is such a variation in the character of the species that it is necessary to know the parentage in order to determine whether they are heat-demanding or coolhouse species. They continue to grow and flower indefinitely.

Læliocattleya elegans (May to September), flowers large, 5 inches, purple rose, fragrant; labellum deep purple;

Læliocattleya Dommanum (C. *Dowiana* × L. *lobata*); light purple, with light line; labellum very dark purple.

385. *Lycaste*, botanical classification. — (Name of uncertain origin.) About thirty species, the most important commercial ones being: *Skinneri*; *candida*; *costata*; *aromatica*; *Harrisoniae*.

386. *Lycaste*, botanical characters. — The pseudobulbs are ovate or ovate-oblong, bearing one to several plicate leaves at the summit. There are also leaves which sheath the stem in young growths. The flowers are produced freely, on erect or semi-erect stalks, each bearing one, sometimes two, rather large flowers. The flower-stalks

come from the base of the bulb. The flowers have good keeping qualities and are excellent for cut-flowers.

Habitat. — South America, Mexico and the West Indies.

387. Culture of lycastes. — For culture, they all require about the same temperature as cattleyas. During the winter, this should be from 50° to 55° at night, with a day temperature of from 60° to 65°. In summer they should be kept as cool as possible. A cool section of the cattleya house will suit them splendidly.

388. Odontoglossum, botanical classification. — (Name from Greek, *tooth-tongue*, referring to the crest on the labellum.) Closely related to *Oncidium*. Species, about 100. The most important are: *crispum*; *grande*; *citrosimum*; *luteo-purpureum*; *nobile*.

Habitat. — *Odontoglossums* inhabit mountainous sections in southern Mexico and south to Peru. They grow at high altitudes in extremely moist atmospheric conditions, with a low temperature throughout the year.

389. Culture of odontoglossums. — This group varies much in temperature and moisture requirements. With the exception of *O. citrosimum* they should have abundant ventilation, with a temperature from 55° to 60°. The temperature requirements for *O. citrosimum* are about 10° higher. All species like a cool moist temperature during the summer. They are grown in baskets or pots. They should be repotted in October and November, but never in summer. For this potting, use a mixture of equal parts of peat, osmunda fiber and live sphagnum moss.

390. Oncidium, botanical classification. — (Name from Greek, *a tubercle*, referring to the crest on the labellum.) Species about 300; the most common ones being:

varicosum, petals green-brown; labellum very large, bright yellow. February to April. Brazil.

tagrinum, red-brown, barred with yellow, labellum yellow. November to January. Mexico.

splendidum, similar to above, but flowers later. February to April. Mexico.

crispum, shining brown, flowers at various seasons. Brazil.

Other important species are *Forbesii*, *ornithorhynchum* and *amphiatum*.

391. Oncidium, botanical characters. — The flowers vary much in color and form, and the flower-clusters also vary in size and shape.

Habitat. — Oncidiums are found native from the hot coast plains of Central America to the high elevations.

392. Culture of oncidiums. The oncidiums should be grown in bright, warm sections of the cattleya house, suspended from the rafters in small baskets.

393. Phalænopsis, botanical classification. — (Name from Greek, *moth-like*, suggested by the large white flowers of some species.) Species about forty. The most common commercial ones are: *amabilis* (December to March); *Sanderiana* (June and July), *Esmeralda* (September and October); *Schilleriana* (December and January).

394. Phalænopsis, botanical characters. — Phalænopsis are very delicately colored. The flowers are borne on long, graceful peduncles which spring from creeping, underground stems. There are two or three radicle leaves which are broad, dark green, thick, leathery and often beautifully mottled.

Habitat. — Plants in this genera are native in the Philippine Islands, Eastern India, Malaya, Sumatra, Java and Borneo.

395. Culture of phalænopsis. — Phalænopsis come from the warmest section of the globe, where the tem-

perature averages from 70° to 75° at night, and 90° to 95° during the day. There are frequent rains during the growing period. Similar conditions should be maintained in the greenhouses. The plants should have plenty of air but drafts should be avoided. The plants are best grown in baskets or porous pots.

396. Vanda, botanical classification. — (From a native name in India.) There are about twenty species. The most important are: *cærulea*, flowers from October to December; *teres*, flowers from May to September; *Kimballiana*, flowers during September and October; *tricolor*, flowers from March to May.

397. Vanda, botanical characters. — Vandas are epiphytes. The flower-clusters are long and graceful, and the individual flowers are mostly large, showy, and of excellent keeping quality.

Habitat. — India and Malaya.

398. Culture of vanda. — Vandas should be grown in baskets near the glass. They like a temperature of from 60° to 65° at night. They require shade after February first.

SWEET PEAS

399. Botanical classification. — Order, Leguminosæ; genus, *Lathyrus* (a name used by Theophrastus for some leguminous plant); species, *odoratus*. Sweet peas are classified by habit of plant into climbing and dwarf types. The former is subdivided into the garden and the winter-flowering groups. Another classification of sweet peas is based upon the form of the flower, viz. the open, the hooded and the waved forms. In the open form the standard is flat or slightly reflexed at the sides. The hooded form includes flowers which have the standard

curled or rolled forward at the edges. Different varieties vary in the extent of this hooding. In extreme cases, the standard appears to be pointed in outline and the apparent size is small. The waved form has the edges of the standards beautifully fluted. The garden and the winter-flowering groups have varieties with flowers of the open, hooded and waved forms. The dwarf type has flowers of open and hooded forms, and if this type were in greater demand outside of California, doubtless varieties of it could be produced with waved flowers.

400. Some present-day varieties of sweet peas are:—

Summer Bloomers

America	Gorgeous	Mrs. Collier
Apple Blossom	Helen Lewis	Nubian
Arthur Green	Henry Eckford	Orchid
Blanche Ferry	Illuminator	Othello
Countess Spencer	King White	Sybil Eckford
Charles Foster	King Edward VII	Salopian
Czarina	Katherine Tracy	Vermilion Brilliant
Dorothy Ecford	Loyalty	Wedgewood

Winter Bloomers

Christmas Pink	Mrs. Wm. Sim
Christmas White	Mrs. Alexander Wallace
Earliest White	Mrs. Charles H. Totty
Gladys Unwin	Mrs. W. W. Smalley
Florence Denzer	Rose Queen
Mrs. F. D. Dolansky	Wm. J. Stewart
	Zvolanek's "Orchid-flowered"

401. Botanical characters.—Annual climbing herbs with pinnate leaves and showy, papilionaceous flowers.

Habitat.—Sicily.

402. Commercial importance.—The sweet pea has rapidly become a popular cut-flower. Since the introduc-

tion of the early-flowering or winter-blooming type, it is possible to have sweet peas throughout the year. Increase in size, length of stem, and number of flowers on the stem have added to its popularity, and the flowers are now grown in large numbers for the American market.

403 Greenhouse culture.—When sweet peas are grown under glass, it is necessary for the house to have full sunlight if possible. An east and west house, with a full southern exposure is best. As the peas grow to a considerable height, it is necessary that the sides of the house be higher than for other crops.

404. Seed sowing in pots.—It is well to be quite certain that the seed has a strong germinating power, before it is sown indoors. Frequently it is wise to start the seeds in pots, and transplant these into the rows. This is particularly true of the white-seeded varieties, which have weak germinating power, or when costly varieties are grown. The seed may be started in two and one-half-inch pots, and later transplanted to the permanent beds.

The white-seeded varieties are usually sown in pure sand. For the others, a finely-sifted, fibrous loam gives the best results. The seed should be sown about two inches deep, and the pots placed in a temperature from 55° to 60°. After the seed has germinated, the temperature should be gradually lowered to 50°, and the pots placed near the glass in a cool, airy house, where a sturdy, short-jointed growth will develop.

405. Planting in permanent beds.—When the plants are two or three inches high, and the soil well filled with healthy roots, they should be planted in permanent beds. Ordinarily, the sweet peas are planted directly in the soil.

406. Season for sowing seed. — Sweet pea sowing is usually commenced by the middle of August, and the plants should be in flower by Thanksgiving, and continue flowering during December and January. The first flowers are usually the best. The second, and principal planting, is made about the second week of September, and the third and last planting, by the first of October. In this way, a succession of blooms may be had until the outdoor crops commence to flower.

407. Seed sowing in soil. — In sowing, a trench should be made from one and one-half to two inches deep, and about six to eight inches wide. The seed is thickly sown in this, and the soil firmed over it.

408. Supports. — As soon as the young plants are three or four inches high, some support is necessary. The birch twigs or mesh wire may be used in the house, but many growers support sweet peas by the use of bamboo stakes and a double row of string. The string is drawn tightly from post to post, at intervals of about eight inches and the plants are tied to this. Whenever possible, the strings are wound around the pipe posts which support the roof.

409. Watering. — During the growing season, sweet peas require an abundance of water. The plants should be syringed frequently to prevent the not infrequent attacks of the red-spider.

410. Ventilation for sweet peas. — The plants require fresh air, but cold drafts should be avoided, for even the slightest chilling induces mildew and a tendency of the buds to drop.

411. Feeding. — The plants should be fertilized from time to time, and for this, a very thin application of pulverized sheep or cow manure is recommended. Some

growers, however, prefer liquid manures. Care should be taken not to stimulate a soft leaf growth by the use of strong, nitrogeaneous manures. Superphosphate and bone meal tend to give the necessary firmness to the tissue and cause the plants to produce an abundance of flowers.

412. Outdoor culture of sweet peas. — An open, sunny location should be chosen for sweet pea culture, as light and air in abundance are needed for a strong, healthy growth. Plants grown in too shady a location are weak and splindling and produce few flowers.

413. Soil. — Any garden soil is suited for sweet peas if it is well drained and dries out early in the spring. The sweet pea is naturally a deep-rooted plant, and to guard against the effects of drought, the preparation of the soil should be deep and thorough. Whenever practicable, it is well to trench the soil in the autumn. If this is not done, a trench at least fifteen inches wide and fifteen inches deep should be dug at the time of planting. The soil should be composted thoroughly with coarse, well-rotted stable manure which is quickly available as plant food.

414. Seed. — Some white and yellow varieties have white or light colored seeds. The white seeds often decay in the soil, especially when it is cold, and their germinating power is thus weakened. Consequently, it is advisable to sow the white-seeded varieties more thickly than black-seeded.

415. Planting. — As soon as the frost is out of the ground, the soil should be prepared for the planting, as the sweet pea is a cool crop. A strong, vigorous root development starts in the early spring, and the growth of the top is short-jointed and sturdy. If the preparation of the soil has been made in the fall, it is best to smooth

the surface and plant the seed. Many growers sow the seed in a broad trench, covering them with about two inches of soil. The seed may be sown in single or double rows. The trench should be open for about six weeks, and then gradually filled in, as the plants develop. Other growers plant on the level, and have excellent results.

416. Supports. — As soon as the seeds are sown, the supports should be placed. If they are not put in place until after the plants have germinated, the seedlings may be injured. For small areas there is nothing better than white birch boughs from four to six feet in length and filled with twigs. In many sections where boughs are not available, wire netting is used for the support. In this case, the mesh of the wire should be large, and strongly supported. The chief objection to wire netting is that in high temperatures it becomes heated, thus injuring the tender growth.

417. Cultivation. — During the summer, sweet peas should be cultivated frequently. This is necessary to maintain sufficient moisture in the soil, especially during a drought. As soon as the ground can be worked after a heavy rain, a hand cultivator should be run through the rows and a soil mulch formed. During July, it is well to use a surface mulch of some strawy material, to prevent the drying out of the soil.

418. Feeding. — After sweet peas are in full flower, fertilizers may be applied. A weak application of liquid manure maintains the size of the individual flowers and the length of the stems for a considerable time.

419. Picking flowers. — The flowers should be kept picked, for they mature quickly, and if allowed to go to seed, there is a dwarfing of the plant, and consequently, a shortening of the flower-stems.

MIGNONETTE

420. Botanical classification. — Order, Resedaceæ; genus, Reseda (from the Latin *to calm*, said to allude to supposed sedative properties); species, *odorata*.

421. Botanical characters. — Mignonette is a branching, annual herb which at first grows upright, but later becomes more or less decumbent and wide-spreading. The leaves are simple. The fragrant yellow and white flowers are borne on spicate racemes which vary in size with different strains of seed.

Habitat. — Northern Africa.

422. Commercial importance. — Although mignonette has been grown under glass for many years, it is only recently that growers have specialized with this crop for winter forcing. Careful selection of seed has resulted in greatly improved strains. Formerly, the mignonette spikes were scattered and comparatively small, now large spikes of dense flowers are being produced. The sprays are very pleasing when arranged with carnations or other flowers having scanty foliage. The fragrance of the flowers adds to their popularity. The demand for mignonette has increased the importance of the crop commercially, until now many florists are specializing in its growth.

423. Greenhouse culture for cut-flowers. — Mignonette will grow in almost any soil, but the large growers prefer a medium light, turfy loam. Pasture sod is excellent, and sod from a field which has been in grass for a considerable time is also good. William Nicholson of Framingham, Massachusetts, has been exceptionally successful in growing mignonette, and from his cultural notes has been compiled the following: —

424. Soil preparation. — In growing good mignonette, a well-prepared soil is of prime importance. The same kind of soil is used as for carnations, and is prepared by first plowing the sod land after the grass has been cut, usually about the first of August. After plowing, the wheel-harrow is used, and then rye and Canadian White cow peas are sown. The last of October or the first of November, a heavy top-dressing of cow or horse manure is applied. Cow manure is preferable. This is plowed under and left until spring. As soon as it is possible to work the ground, the land is wheel-harrowed several times and an application of manure is made. The soil is plowed again, well disked, and bone meal applied, about one ton to the acre; the land is then ridged and the soil is ready for the benches. This method of preparation eliminates much hand work, and there is little danger of the soil becoming sour, as it frequently does if the compost method is used.

425. Filling benches. — Most growers prefer to grow mignonette in raised benches about five inches deep. An inch of well-rotted stable manure is placed on the bottom of the bench, and the remainder is filled with the composted loam.

426. Seed sowing. — The surface of the soil is leveled carefully and marked off in rows six by eight inches apart. From six to ten seeds are dropped at the intersection of each row, and covered very lightly. A light watering with a fine sprinkler is then given the soil to settle it around the seeds.

Three sowings of seed are made each year, — on the first weeks of July, August and September. The last sowing flowers until the next July. After the seeds have germinated, and the seedlings have developed the third

leaf, three strong plants are selected and the others removed. Seed for next season's crop is taken from the plants started in September. The plants which produce good foliage and compact flower-spikes, with large, individual flowers, are selected as the seed-bearing parents.

427. Ventilation. — Great care should be taken that the seedlings started in July get sufficient air. The ventilators should be kept open day and night, to keep the plants stocky and short-jointed. During bright weather, temporary shading is necessary in the middle of the day, until the seedlings get their second leaf, then full sunlight should be given.

428. Removal of side shoots. — After the flower spikes begin to appear, all side shoots should be removed from around the top of the stem. Three or four strong bottom side shoots are left for a second crop. In this way, a succession of blooms may be obtained throughout the winter.

429. Supports for mignonette. — As soon as the plants are well developed, a wire ring is placed about each plant. Later wires with cross strings are used for supports, the same as are used for carnations.

430. Watering. — Mignonette is injured by over-watering, and great care should be taken that the soil be not too wet, especially when the plants are just started. As they develop, watering should be done only on bright mornings, for if water remains long on the foliage, the leaves become spotted.

431. Temperature. — A night temperature from 45° to 48° best suits mignonette. On cloudy days the temperature should be kept at 55°, and on bright days it should never be allowed to go above 65°.

432. Feeding. — When the plants have developed

sufficiently so that flower spikes are forming, they will require additional food. It is composed of one part sheep manure and two parts of loam. The two are thoroughly mixed and three large handfuls of the mixture are scattered about the plants in a row across a three-foot bench. Instead of this top-dressing, they may be given a weak solution of liquid manure. A bushel of sheep manure is put into a bag and suspended in a barrel of water for two or three days. The bag is then removed and the plants watered with the liquid.

433. Pot culture. — Mignonette is grown in pots to a limited extent. There is some demand for it at Christmas and Easter, and some florists always have pot plants in stock. It is more difficult to grow in pots than in beds, as it is necessary to have compact, stocky plants. This requires a great deal of care.

434. Seed sowing. — The best method of mignonette culture in pots, is to fill two and one-half-inch pots with finely sifted soil, which has been prepared the same as described for bench culture, and to sow the seed in this soil. It should be remembered that the mignonette will not transplant; therefore, the seeds should be sown exactly where the plants are to grow. Several seeds should be sown in each pot to insure a perfect germination, and after this has taken place, and the plants are well developed, all but one plant should be removed. The young plants should be kept as near the glass as possible to foster a stocky growth. Great care should be taken not to let the plants dry out, neither should they be over-watered.

435. Re-potting. — As soon as the soil is filled with the feeding roots, the plants should be re-potted, and this re-potting should be done frequently, the plants never being allowed to become pot-bound.

436. Pinching. — When the plants are from four to five inches tall, they should be pinched, and the side shoots allowed to develop. When they have grown to a height of six or seven inches, they should be staked and tied, and again pinched back to encourage branching. The large flower spikes are not desired in pot grown plants, but a greater number of smaller spikes. Pinching makes the plants much more symmetrical. When the plants are in flower, they should be in seven- or eight-inch pots.

437. Outdoor culture. — As a garden flower, the mignonette is by no means showy, but its delicate fragrance makes it popular. It requires a cool, well-drained soil and one which is moderately rich in decayed organic matter. It does not like the full sunlight, so should be given a spot in the garden which is shaded a part of the day. The seed should be sown late in April, and a second sowing may be made early in July, so that the season of bloom be extended until the time of severe frosts.

ANTIRRHINUMS

438. Botanical classification. — Order, Scrophulariaceæ; genus, *Antirrhinum* (Greek for snout-flower); species, *majus*. The species is divided into three groups: the giant or tall growing; the semi-dwarf; and the dwarf or Tom Thumb. The first section grows about three feet high, out of doors, and as high as six feet under glass. The semi-dwarf grows from twelve to fourteen inches high out of doors, and to three feet high under glass. The dwarf varieties grow about six inches high, and are used principally for bedding (Fig. 30).

439. Botanical characters. — Snapdragons are herbaceous perennials, but under cultivation they become

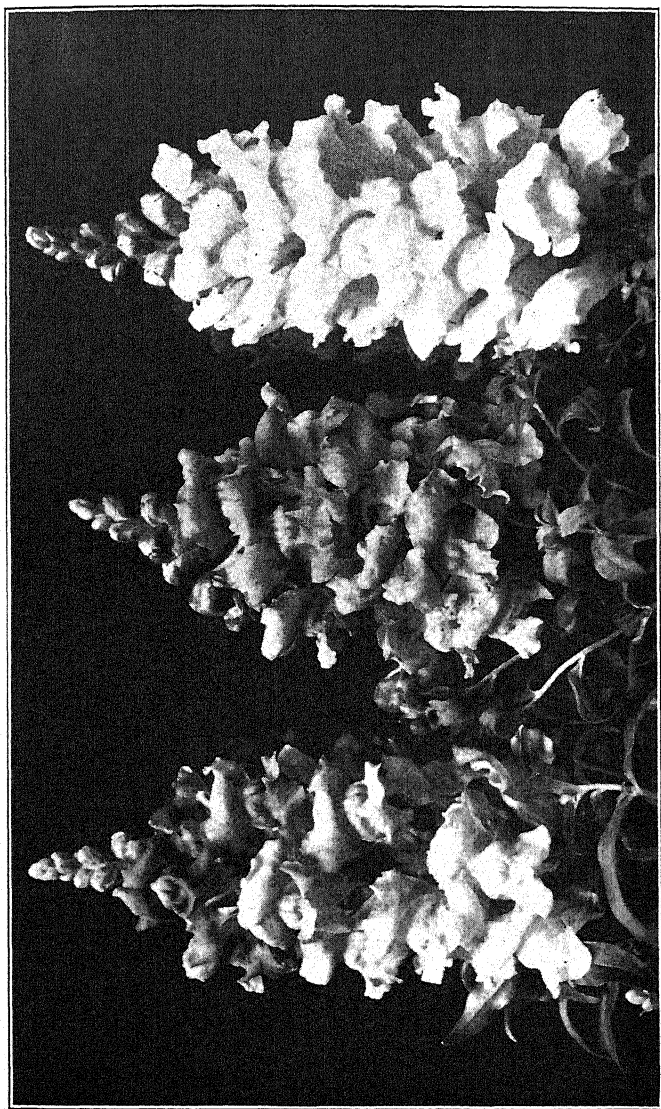


FIG. 30. — Dwarf varieties of antirrhinum.

practically biennials. They are not entirely hardy in the northern part of the United States, hence require careful winter protection. They have opposite, entire leaves, and produce long, terminal spikes of showy flowers. They are usually in shades of pink, red, yellow or white. There are many varieties, and they vary in size and in the color of the flowers. For culture under glass, the semi-dwarf varieties are the most desirable.

Habitat. — Countries bordering on the Mediterranean Sea.

440. Commercial importance. — Snapdragons have recently come into quite general favor for cut-flowers. This is due largely to the improvements in varieties. F. W. Fletcher of Auburndale, Massachusetts, has had marked success in growing this species. His suggestions have been followed in the following cultural notes.

441. Culture. — Antirrhinums make an excellent crop to follow chrysanthemums. The principal type grown under glass is catalogued as "*nanum grandiflorum*." This has many named varieties which are as continuous in their blooming characters as are the carnations.

442. Propagation. — Antirrhinums are propagated by seed or by cuttings, and experts disagree as to which method is best. Seeds of well-established varieties will usually give from fifty to seventy per cent of flowers true to color. There is, however, considerable variation in the height of growth. Seedlings make a quicker, more succulent growth, but it renders them more susceptible to serious leaf-spot diseases. Seedlings also have a tendency to produce a spike with the flowers loosely arranged. Propagation by cuttings is, therefore, more generally preferred. For early flowering plants, cuttings are taken or seed sown in March or April, and the resulting plantlets

are kept in vigorous growth throughout the spring. About the middle of May, the plants should be plunged out of doors in a cold frame or in an open field. Here they are pinched to induce branching, and every effort made to stimulate a strong growth. A plant, stunted in its development, is of little value for cut-flowers.

443. Season for planting in greenhouses. — Plants for early flowering are placed in the greenhouses from July first to August fifteenth. For later flowering, the seedlings or cuttings may be propagated as late as June. They are grown in pots, under cool conditions during the summer, and may be planted in beds in the fall after the chrysanthemums have been removed. The plants may be grown either in raised benches, or in solid beds. Benches will give earlier blooms, but if the flowers are desired for Memorial Day or later, solid beds are preferred.

444. Soil and its fertilization. — Antirrhinums grow best in a light soil, which should be prepared the same as for mignonette culture. No fresh animal manure should be used when the benches are filled, for a strong, active compost is especially injurious to this plant. One successful grower gives the soil a liberal application of finely ground limestone and rock phosphate.

The effect of too much nitrogen in the soil may be detected by the tendency of the flowers to "sport." The dominant yellow color of the antirrhinum becomes evident. The pink and white varieties will show a yellow lip, and often the whole flower is suffused with yellow. This injures the sale of the flower, for the market demands pure, solid colors.

445. Planting and watering. — As soon as the benches are filled with soil, the plants are planted firmly eight by ten inches apart. After planting, they are given a thor-

ough watering. Later, only enough water is given to keep the plants from wilting, for antirrhinums will not grow in a wet soil. Their natural habitat out of doors is on dry banks or even in crevices in rocks. Special care in watering should be taken on dark days in mid-winter. They should never be syringed in winter, but on bright days in spring, a thorough syringing will be beneficial.

446. Temperature. — A night temperature from 48° to 52° suits the antirrhinum. If the temperature occasionally falls to 45°, the plants will not be injured. The day temperature should not go above 70°.

447. Feeding. — After the plants are once established in the beds, they require very little feeding. If the soil is light and there seems a lack of plant food, a moderate application of bone-meal may be given. This will cause the plants to produce stronger stems. No quick-acting fertilizer, such as nitrate of soda, should be used, but small amounts of liquid cow manure may be given occasionally.

448. Insect pests. — Antirrhinums are troubled by few insects. They may be attacked by the green and black aphids, and this should be controlled by fumigation with some extract of nicotine. The leaf-roller is sometimes troublesome, and must be hand picked, for applications of arsenate of lead discolour the foliage. The plants are also easily injured by fumigation with hydrocyanic acid gas.

WALLFLOWERS

449. Botanical classification. — Order, . Cruciferae; genus, *Cheiranthus* (derivation in dispute, but probably from the Greek for *hand* and *flower*); species, *Cheiri*.

450. Botanical characters. — Wallflowers are herbaceous plants with an upright habit of growth. The flowers are in terminal spikes, and are yellow, red or yellow-brown in color.

Habitat. — Southern Europe.

451. Commercial importance. — Wallflowers are yearly becoming more popular as cut-flowers. Some markets demand a liberal supply throughout the winter months.

452. Culture. — They are easily grown, and are attractive, either as cut-flowers or as potted plants. The seed is sown in March. Early in May, when the seedlings are well established in three-inch pots, they are planted in the field. Here they are given careful cultivation during the summer, and early in October they are carefully lifted, breaking as few roots as possible, and planted in raised benches or solid beds in the greenhouses. The plants are spaced about twelve inches apart and the soil should be similar to that in which carnations are grown.

Wallflowers require a cool house, and the night temperature should never go above 45° or 50°. They need a liberal supply of water and careful ventilation. When they are lifted in the fall, they may be potted in six- or eight-inch pots, and grown the same as in beds. If cut-flowers are desired in late spring, the plants may be wintered in a coldframe with leaves packed about them. The last of March the plants should be brought into the house and forced into bloom.

TEN-WEEKS STOCKS

453. Botanical classification. — Order, Cruciferæ; genus, *Matthiola* (after Peter Andrew Matthioli, an Italian physician and writer on plants); species, *incana*; variety *annua*.

454. Botanical characters. — Stocks are annual, herbaceous plants, bearing the flowers in an open, terminal raceme. The flowers are white, rose, crimson or purple, and very fragrant. The lighter shades are most in demand.

Habitat. — Mediterranean region.

455. Commercial importance. — Stocks are extensively grown, especially for cut-flowers in late spring. They are in considerable demand for Memorial Day.

456. Culture. — The culture of stocks is much like that of antirrhinums, except that stocks are always propagated by seed, and several sowings are made during the year. The first sowing should be made in July, and this should be followed by sowings in September, November and January. By so doing, a succession of bloom may be had from November throughout the year.

LUPINES

457. Botanical classification. — Order, Leguminosæ; genus, *Lupinus* (from the Latin *lupus* — a *wolf*, because a crop of Lupines was supposed to destroy the fertility of the soil). Species most commonly grown under glass: *mutabilis*; *nanus*, variety *albo-coccineus*; *Hartwegii*; *hybridus*, various varieties. A variety called the Pink Beauty is now commonly grown (Fig. 31).

458. Botanical characters. — Lupines are annuals or herbaceous perennials, with very showy, pea-shaped, blue, white, yellow or pink flowers, produced on a close terminal spike. They have clean, handsome, divided foliage.

Habitat. — North America and the Mediterranean region.

459. Culture. — The annual lupines have but recently come into favor as greenhouse plants, and they are grown

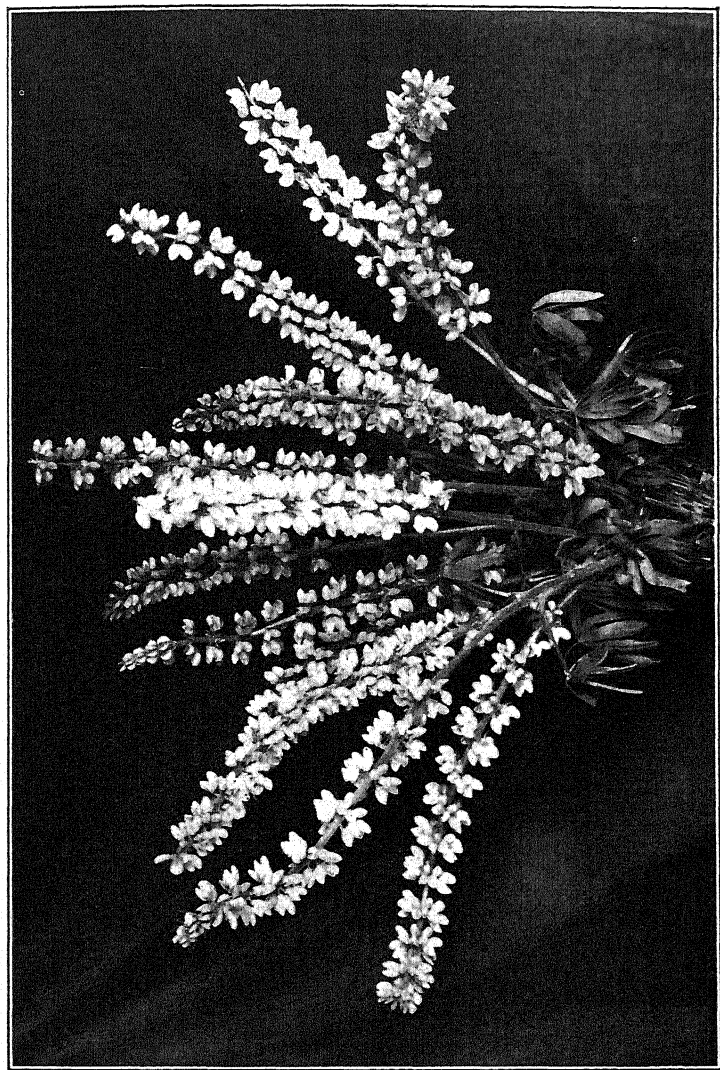


FIG. 31. — Lupine, "Pink Beauty."

only to a limited extent commercially. They are easily grown and are valuable for cut-flowers during the winter and early spring. For an early crop, which will bloom in January and February, the seed should be sown about September 10. For later bloom, seed should be sown in January. Later sowing in April will bloom by Memorial Day. Two or three seeds are usually sown together, and when the seedlings are well developed, three of the groups of seedlings are potted into a six-inch pot. This makes a compact attractive plant. If the plants are to be grown in shallow benches, the clumps are planted in rows twelve inches apart. They are spaced eight inches apart in the row. For spring crops, the seed is sown directly in the benches or in the pots where they are to bloom. The soil should be of a light, porous character, well enriched with thoroughly decayed compost.

When large fancy spikes are desired, the varieties of *mutabilis* are grown. They require a longer season to develop. They are vigorous growers and occupy considerable bench space. The rows are usually spaced two feet apart, and the plants are placed nine inches apart in the rows. Seeds sown in October will give fine blooms from February to April.

The plants are liable to "damp-off," even when of considerable size, if the soil is too retentive of moisture, or if watered injudiciously. It is a safe plan to keep the plants rather dry in mid-winter. After March first, there is little danger of over-watering. They are very susceptible to mildew, therefore they should never be sprayed or exposed to cold drafts.

Lupines grow best in cool houses. A minimum night temperature of 45° is sufficient, and this should never go above 48° in mid-winter.

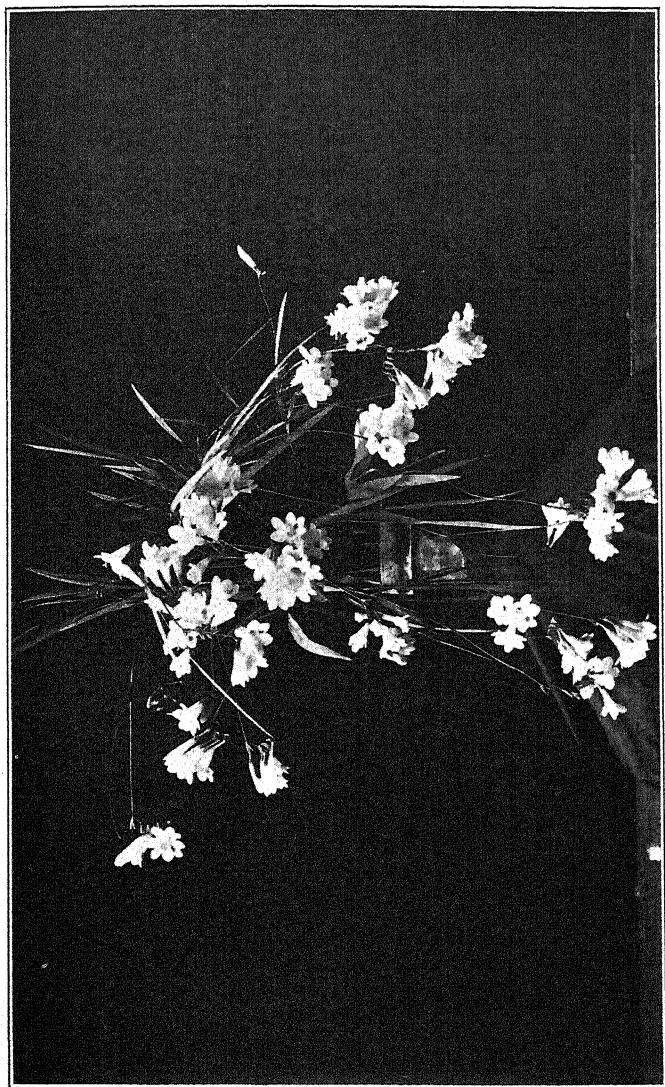


FIG. 32. — Freesia.

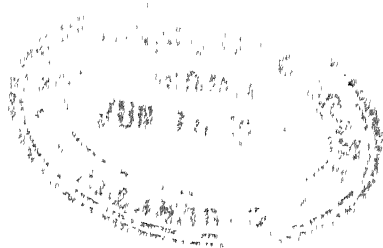
FREESIAS

460. Botanical classification. — Order, Iridaceæ; genus, *Freesia* (origin of name unknown); species, *refracta alba* (Fig. 32).

461. Botanical characters. — Freesias are low-growing, annual plants with narrow leaves. From between them, a slender peduncle arises, and bears at the top from five to seven white or pale yellow, tubular flowers. The flowers are spread along a jointed axis which is bent backwards almost at right angles to the vertical peduncle. They have a strong fragrance quite unlike that of any other flowers.

Habitat. — Cape of Good Hope.

462. Culture. — Freesias are much forced for cut-flowers, and they are also excellent for indoor boxes in sunny windows, or may be grown along the borders of carnation benches. They may be had in flower from Christmas until June, by successive plantings from August until February. For the best results, the largest bulbs should be planted as early as August. It is not necessary to place them in a cool, dark cellar or in a frame to develop the root system. They may be started into growth at once in a temperature of from 55° to 60°. Freesias are not suited for outdoor culture.



CHAPTER XV

POTTED FLOWERING PLANTS

WELL-GROWN plants, covered with a profusion of bloom, are very attractive and for such there is always a demand. A half-starved, poorly grown plant is an object of pity, and the culture of plants in pots should not be attempted unless they can be given the care necessary to develop them to approaching perfection. Because of their restricted root area, they are quickly affected by neglect, and they require even more careful attention to details of culture than do plants grown for cut-flowers, in beds or benches.

Among the genera most frequently grown are cyclamen, primulas, calceolarias, cinerarias, schizanthus, begonias, gloxinias, hydrangeas, acacias, genistas, ericas, azaleas, poinsettias, gardenias, Easter lilies, calla lilies and oxalis. Other potted plants are described in Chapter XVI.

- CYCLAMEN

463. Botanical classification. — Order, Primulacæ; genus, *Cyclamen* (Greek word for *circle*, referring to spirally twisted peduncles of flowers); species, *persicum*; some varieties are: *giganteum*; *Salmon Queen*; *Peach Blossom*; *Vulcan* (Fig. 33).

464. Botanical characters.—Cyclamen are low, herbaceous plants which form on tuber-like corms. The

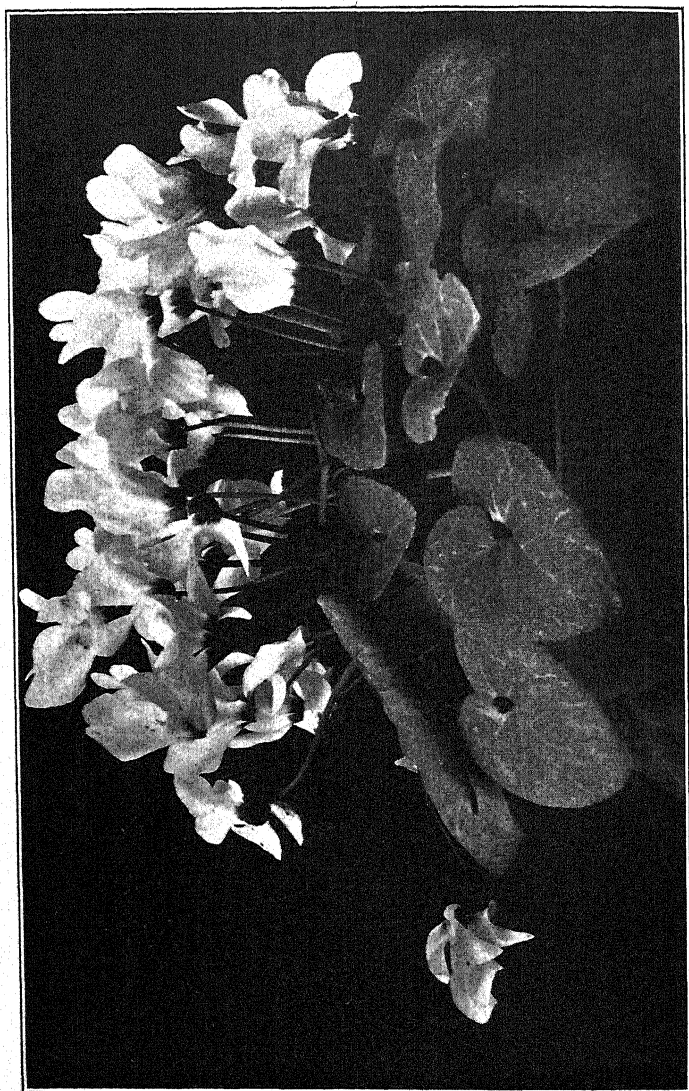


FIG. 33. — *Cyclamen persicum*.

flowers are single or double, with a five-parted calyx and corolla. The leaves are ovate, dark green, leathery, usually marbled or variegated with white. The flowers are on stems six or seven inches high, and are mostly odorless, usually white, but ranging in rose-colors and red forms.

Habitat. — Persia and countries along the Mediterranean.

465. Commercial importance. — Cyclamen are becoming more valuable each year as commercial plants. There is no winter-flowering plant which has a longer or more prolific period of bloom, and none forms a more attractive plant, with the beautiful foliage and compact habit of growth. Grown well, they are beautiful, but when poorly grown, they are ugly.

466. Propagation. — The seed of the cyclamen is sown in shallow pans during September. Considerable leaf-mold should be used for seed pans, and this should be covered with a glass and kept in a cool, airy place until the first leaves appear. Over-watering should be avoided, or green mold will form over the surface of the soil. The seeds germinate slowly, as a bulb forms before seed leaves appear. It often takes two months or more for this germination.

467. Pricking off seedlings. — As soon as two leaves have formed, the seedlings should be pricked off into small, wooden flats. They are placed on a shelf near the glass, where they may get excellent air circulation. They should be watered carefully, as the roots are produced slowly, and over-watering will rot them.

468. Potting. — When three or four leaves are formed, they are potted into three-inch pots. This should be done in February or March. The soil for this potting should be one-half leaf-mold, one-fourth sifted, dried cow manure,

and one-fourth loam, with a sprinkling of sand. The plants should be kept in a light, airy place where the temperature does not go above 55° at night. About May first they should be re-potted into similar soil, and care should be taken not to over-water them when first potted.

469. Summer treatment. — About May fifteenth, they are removed to a coldframe where they are covered with a lattice frame or cheese-cloth screen. They are re-potted again in July into five- or six-inch pots, returned to the frame and left until September first. They should be syringed frequently during the summer. If especially large plants are desired, they are re-potted into seven- or eight-inch pots when they are brought into the house. If not re-potted, it is well to begin at once to feed liquid manure in dilute form, strengthening it as they begin to flower. The temperature should be kept low, or the buds will blast. It should rarely go above 50° at night, and not over 65° in the daytime. Green-flies and thrips may be prevented by packing the pots in tobacco stems during the summer.

Light fumigations may be given before the buds appear. Giganteum varieties are less desirable than the smaller-flowering varieties, as they are less prolific of bloom. The bulbs may be used a second year. They are dried off slowly, but not allowed to become bone dry. They are potted by the fifteenth of April, and given the same summer treatment as described for the first year's growth.

PRIMROSES

470. Botanical classification. — Order, Primulaceæ; genus, *Primula* (an old name given *Primula veris*, one of the first spring flowers); species, Indoor: *sinensis*;

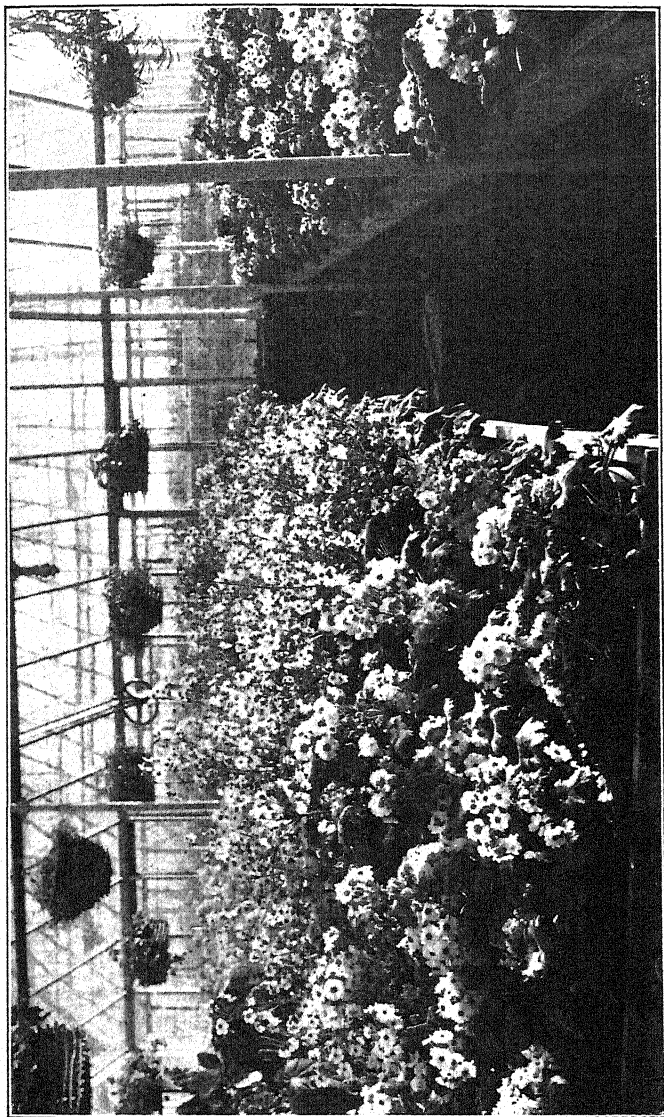


FIG. 34. — A house of primroses.

stellata; *Forbesii*; *obconica*; *malacoides*; *kewensis*. Outdoor: *Auricula*; *japonica*; *cortusoides*; *Polyantha*; *vulgaris* (Fig. 34).

471. Botanical characters. — This group of plants is especially good for home use, as the species are easy of culture and good for outdoor gardening as well as indoor. They are cool-loving plants and are especially attractive when in flower. Their season of bloom is long when grown in the greenhouse. They embrace a wide range of colors, especially in the species *sinensis* and *Polyantha*.

Sinensis has been crossed and recrossed, the result being many excellent strains. The flowers are showy, being pink, lilac, purple, yellow, red and white. The plants are naturally low herbs in their character of growth, with many radical roots springing from near the base of the stem. The flower-clusters rise from near the center of the plant, and bear many flowers in whorls.

Habitat. — Primroses are natives of the North Temperate zone; they are mostly Alpine plants of the colder sections. Most of the indoor species are of Chinese origin.

472. Propagation. — Propagation is mostly from seeds, which if sown in February and March furnish large plants for flowering the next winter. It is wise to buy the best strain of seeds, and they should be soaked for a few hours before sowing.

Always use clean pans, and place in the bottom a few pieces of broken crock. Cover this to within one-half inch of the top with finely sifted garden loam. The soil should be uniform in density and not too compact. The seeds are sown evenly and thinly, then pressed into the soil and covered lightly with a mixture of one-half finely sifted loam and one-half sand. They should be watered slowly, but thoroughly, with a bulb spray. The pan should be covered

with a glass and placed in a warm, shaded place. The temperature for germination should average about 70°. The pans should always be kept moist and shaded.

473. Culture. — When the seedlings have developed their true leaves, they should be pricked out. It is best to put them into a small box, as they dry out less easily. The seedlings are placed about one inch apart, using a soil composed of three-fourths garden loam, and one-fourth well rotted manure. If the manure is not well rotted, it is better not to use any. When the plantlets are well developed, they are transplanted to small pots and to larger ones as required, never allowing them to become pot-bound. A very little manure and bone-meal is used in the soil, which is made a little richer at each re-potting. They should be put in their flowering pots just as the flower-buds appear in the crown of the plant. The soil for this re-potting should be well enriched, for the period of bloom is a long one. If there is a yellowing of the foliage, and an apparent weakening of the plant because of lack of plant food during the blooming season, this may be overcome by frequent applications of weak liquid manure. The crown of the plant should not be placed too deeply in the soil or it will decay; neither should it be too high or the plant will topple over. When first transplanted, primroses are kept shaded and in a temperature of about 70°. Later they are given plenty of air, full sunlight and never allowed to become dry.

474. Outdoor primulas. — Outdoor primulas are excellent for cut-flowers for house decoration. The seed is sown in January in pans as for indoor culture, and kept in a cool, slightly shady place. The plants are put in the coldframe in April and transplanted to their permanent planting in May. They may be lifted in the fall, potted,

and placed where the plants will freeze, covering the pots with soil so they will not break. They may be taken into the house about the first of December for forcing.

CALCEOLARIAS

475. Botanical classification. — Order, Scrophulariaceæ; genus, *Calceolaria* (Latin *calceolus* — a slipper — alluding to the saccate flowers); species: *arachnoidea*, mostly purple; *crenatiflora*, mostly yellow with orange-brown dots; *corymbosa*, clear yellow with small flowers. Most greenhouse forms are hybrids of the first two, and are known as *herbeohybrida* or *arachnoideo-crenatiflora* (Fig. 35).

476. Botanical characters. — Greenhouse species of calceolarias are herbaceous annuals. The corolla is two-parted nearly to the base, the lower part inflated and slipper-like, and the upper part smaller and ascending, still usually saccate. They are variously colored in intense rich shades of yellow and red. The fruit is a capsule filled with tiny seeds.

Habitat. — South America, Mexico and New Zealand.

477. Propagation. — Most calceolarias are hybrids, and are grown as greenhouse annuals for decorative purposes in March, April and early May. The seed is very fine, almost as fine as fern spores, and must be most carefully sown and tended. The first sowings for flowering in March should be made the last of June, and to have a succession of bloom, sowings should be made about once in three weeks until the last of August.

478. Culture. — The soil should be composed of equal parts of leaf-mold, sand and sod-loam. The seed-pans should be perfectly clean, and plenty of drainage for the bottom of the pan should be provided. The pots should



FIG. 35.— *Calceolaria herbeohybrida*.

be filled carefully and firmly so that the soil will not settle after the seeds are sown; and the surface should be perfectly level. The soil should be watered several hours before sowing the seeds, so that the surplus moisture may drain off. Stir the soil, then scatter the seeds thinly and evenly over it. Do not cover the seeds but fit a pane of glass closely over the pan. The glass should be shaded until the seedlings have germinated, requiring about two weeks, when the glass should be removed carefully. Water may be given by setting the pan in water for a few minutes only. If the right proportion of leaf-mold, sand and soil has been used, the surface soil will not crust over.

The seed-pan is next placed in a frame. When the seedlings have formed their third leaf, they should be pricked off into pans or shallow flats, putting them one inch apart. The compost should be similar to that used for seeds. As soon as plants appear crowded they should be potted into thumb pots. Add to the soil mixture one-sixth part of dried, sifted cow manure for this potting. The plants should be re-potted occasionally to avoid becoming pot-bound, until well established in seven-inch pots, when they will begin to flower. The flowers will be better if the plants are slightly pot-bound. The plants should be kept in an airy house of northern exposure during the summer, and the day temperature should be as nearly 50° as possible. If the temperature goes to 65° or 70° even once, the crop may be seriously injured. Partial shade should be given, enough light being required to prevent the plants from spindling. They should have plenty of air, and all accumulation of water on the foliage should be avoided. When the flower buds begin to form, a weak manure water should be given about once a week. They should be kept in a moderately dry atmosphere, particu-

larly after the flowers begin to form. The green fly may be kept in check by placing tobacco stems around the young plants, or by vaporizing some tobacco extract in the house. Fumigation with tobacco stems should not be practiced, as it blackens the foliage.

CINERARIAS

479. Botanical classification. — Order, Compositæ; genus, *Cineraria* (Latin, — *ash colored*, — referring to the gray foliage in some species); species: *cruenta*, dwarf cinerarias, *cruenta*, *flore-pleno*, double; *cruenta* var. *stellata*, tall, branching.

480. Botanical characters. — Cinerarias are herbs which have heavy, compact foliage, terminated by large panicles of showy composite flowers. The flowers are very brilliant and embrace a wide range of colors in shades of blue, white and red. As ornamental plants, they are grown as annuals, the plants being valueless when their flowering season is over.

Habitat. — Canary Islands.

481. Propagation. — Cinerarias are very popular plants for house decoration because easily grown. They are mostly propagated from seed. Double varieties are sometimes propagated by cuttings as they do not seed freely. The seed may be saved from plants each year, but unless care is taken in crossing desirable colors, it soon deteriorates. It is better to buy new seed each year. Two or three sowings should be made to insure a succession of bloom; the first being about the first of August, the second about the first of September, and a third about the middle of September. The seed should be sown and the seedlings given the same care as *calceolarias*, except that

these seeds should be covered to a depth of one-eighth inch with a mixture of finely sifted leaf-mold and sharp sand.

482. Culture. — After the seedlings germinate, a little fine clean sand should be sifted over the top of the pan. This prevents damping off. Water should be given the same as for *calceolaria* seed. The seed should be placed in a cool, shaded place, where they should germinate in about ten days. When large enough to handle, the seedlings should be transplanted into thumb pots. Small plants should not be discarded, for many of the most desirable colors germinate slowly.

The plants should be kept growing vigorously, and not allowed to become pot-bound. A mixture of equal parts of mold and fibrous loam gives excellent results until the plants are ready for five- or six-inch pots, when a compost of three parts fibrous loam and one part well-decayed cow manure should be used. The night temperature should be kept as nearly as possible at 45°, and the plants should be near the glass. They should be in their flowering pots at least six weeks before they are to begin flowering. This makes compact growth and large, dense flower heads. If not somewhat pot-bound, the growth will be stronger and the flowers fewer. If growth is not satisfactory, the plants may be fed occasionally with liquid manure. The green fly may be kept in check by frequent fumigation with tobacco products, or by keeping tobacco stems scattered among the pots. The double-flowered varieties may be propagated by cuttings. As soon as the flowering season is past, the flower-stems may be cut back to induce a strong growth of young shoots. These may be rooted in the propagating bench the same as other plants. They should be kept cool, even during the summer.

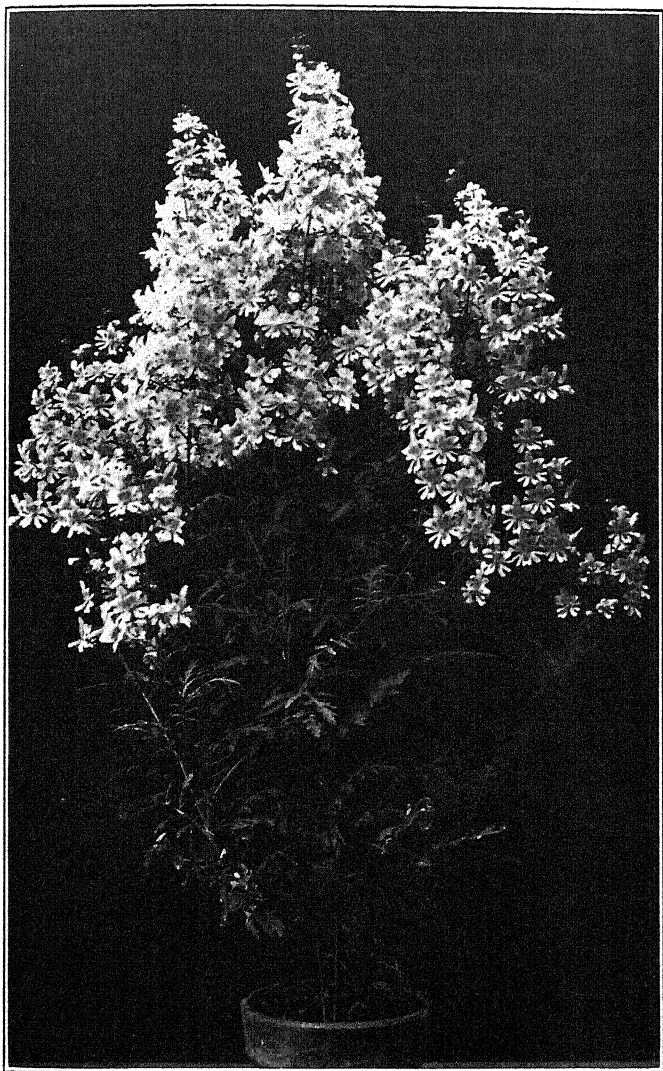


FIG. 36. — *Schizanthus pinnatus*.

SCHIZANTHUS OR POOR MAN'S ORCHID

483. Botanical classification. — Order, Solanaceæ; genus *Schizanthus* (Greek *split* and *flower*); species, *pinnatus*.

484. Botanical characters. — The schizanthus is an annual plant with finely-cut foliage, and terminal, open clusters of many small, daintily-colored flowers (Fig. 36). They are excellent for cutting. The flower clusters are produced in great numbers. It is an excellent species for garden flowers, for window boxes, and for conservatory plants, because of its light and airy character.

Habitat. — Chile.

485. Culture. — The seeds germinate easily, grow rapidly, and come into bloom quickly. They may be sown in the ground in May, or the plants may be started in the greenhouses in April. This gives a longer period of bloom. They are of great value in conservatories as an early spring-flowering annual. The seed is sown in September, and the plants pricked off into flats, to get good, stocky plants. They should be kept in a temperature from 45° to 50° at night. The soil need not be especially rich; a fine, fibrous loam, enriched with one-third well-rotted cow manure is good. Attacks from red-spiders may be kept in check by frequent sprayings. A new variety of this flower, the Bridal Veil, is very popular.

GLOXINIAS

486. Botanical classification. — Order, Gesneraceæ; genus, *Sinningia* (after Wilhelm Sinning, gardener at the University of Bonn); species, *speciosa*.

487. Botanical characters. — Herbaceous plants with tuberous rhizomes. The foliage is densely pubescent.

The flowers are large, bell-shaped or trumpet-shaped, with rich, brilliant colorations.

Habitat. — Brazil.

488 Commercial value. — Gloxinias are desirable for early spring and summer flowering. They are sold in considerable numbers as potted plants.

489. Propagation — Gloxinias are propagated by seed or by cuttings made from leaves or stems. The seeds usually give the best results unless it is desired to maintain a strain which is unusually choice. The mature, medium-sized leaves are selected, and a small portion of the leaf-stalk is left attached to the blade of the leaf. They are inserted in an ordinary propagating bench where they will soon root and form tubers. The plants are then potted and kept growing until sufficiently mature to produce blooms.

Seeds should be sown early in February in a mixture of finely sifted leaf-mold, sand and fibrous loam. They are better propagated in pans or shallow boxes, and kept in a temperature of 65° to 70°.

490. Culture. — The seedlings should begin to appear in about ten days, and then much attention should be given to watering and ventilation, to prevent the common attacks of the damping-off fungus. As soon as the seedlings can be conveniently handled, they are potted in thumb pots. The soil should consist of two parts leaf-mold and one part fibrous loam. The plants should be well shaded from sunlight, and ventilated with great care, but never chilled. During growth, they require a night temperature of about 60°. The seedlings should begin to flower in August, and should then be given an airy house with partial shade. When the season of bloom is completed, and the leaves mature, water should be gradually withheld.

The pots may be placed on their sides underneath the

benches and the leaves ripened. The tubers should be stored in a temperature of about 45°, and be sufficiently moist so as not to shrivel. It is an excellent plan to pack them in dry sand for the winter.

Near the middle of February, the tubers will begin to show signs of starting into growth, and the largest should be re-potted at this time. They should be put into pots just large enough to accommodate the tubers, and be given but little water until active root growth begins. They should begin to blossom in June and continue to flower throughout the summer.

BEGONIAS

491. Botanical classification. — Order, Begoniaceæ; genus, *Begonia* (after M. Begon). Sections:

- (a) Semi-tuberous or Socotrana.
- (b) Tuberous or Summer-flowering.
- (c) Rex or Ornamental-leaved.
- (d) Fibrous-rooted or Winter-flowering.

The most important species are:

Section (a) *socotrana*.

Section (b) <i>boliviensis</i> ,	<i>Froebeli</i> ,
<i>Veitchii</i> ,	<i>rosæflora</i> ,
<i>gracilis</i> ,	<i>geranioides</i> ,
<i>Pearcei</i> ,	<i>Clarkei</i> .
<i>Davisi</i> ,	

Section (c) *Rex*.

Section (d) <i>Scharffiana</i> ,	<i>Haageana</i> ,
<i>metallica</i> ,	<i>peltata</i> ,
<i>incarnata</i> ,	<i>foliosa</i> ,
<i>fuchsioides</i> ,	<i>albo-picta</i> ,
<i>manicata</i> ,	<i>scandens</i> ,
<i>semperflorens</i> ,	<i>nitida</i> ,
<i>Dregei</i> ,	<i>argenteo-guttata</i> .
<i>coccinea</i> ,	

There are many named varieties in each section.

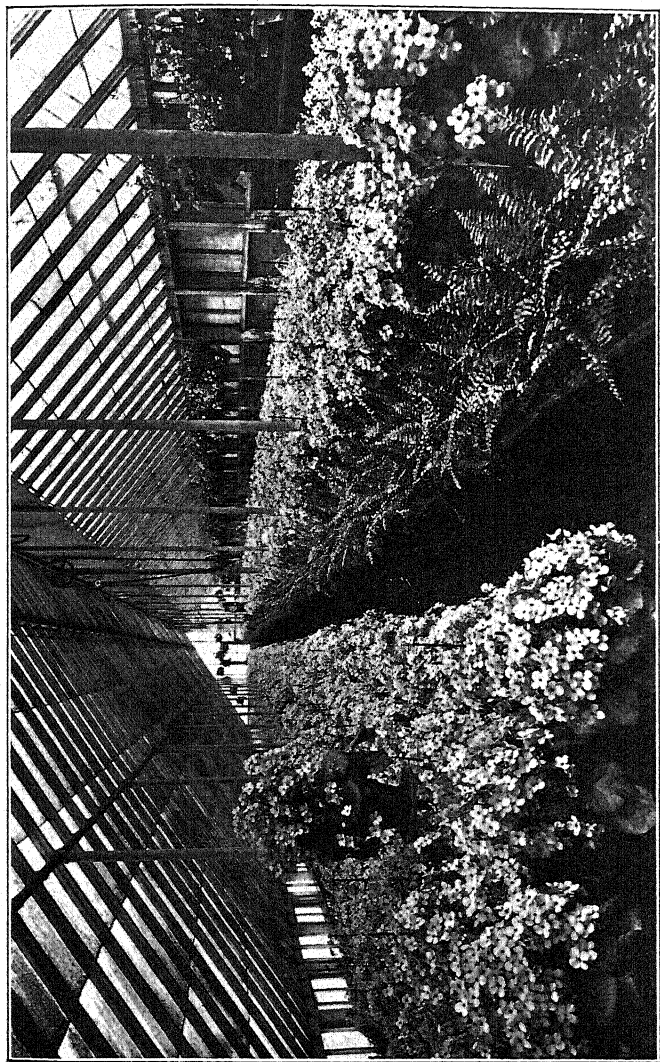


FIG. 37. — A house of Begonia, "Glory of Cincinnati" (semi-tuberous type).

492. Semi-tuberous begonias (Fig. 37). — Within comparatively recent years a new race of begonias has come into popular favor. The abundance of bloom and the attractive habit of growth make this group of great value. Hybrids between *socotrana* and species in the fibrous rooted section have given some remarkable varieties. Among them are Gloire de Lorraine, Glory of Cincinnati, Winter Cheer, Turnford Hall, Caledonica, Mrs. Heal, Melior, and Mrs. Peterson.

Habitat. — From the hot, sandy island of Socotra.

493. Propagation. — The semi-tuberous type of begonia is propagated almost entirely from leaf cuttings. They are usually taken early in November, for they require a long period in which to develop plants for flowering the next winter. They also require a steady bottom heat, and such is better maintained during the winter.

Well-matured, perfect leaves selected from healthy plants are taken for cuttings. The leaf-stalk is cut about one-half inch below the leaf blade, and inserted in the sand until the base of the leaf is in close contact with the sand. If the leaf is tilted somewhat, there is less danger from the damping-off fungus. The cutting should be placed firmly in the sand and thoroughly watered. A steady bottom heat of not less than 70° should be maintained, and the atmosphere in the propagating house should be somewhat close and humid; still, the house should be ventilated and the air fresh, or a large number of the cuttings will decay. It is an excellent plan to have a propagating case for the cuttings, so that while fresh air is being admitted to the house, they may be covered to prevent drafts and chilling. The cutting bench should not be exposed to direct sunlight. Care should be taken to

prevent the cuttings from drying out, and every effort made to prevent decay.

494. Culture — The cuttings should root in six or eight weeks, and by the first of January they should be ready for two and one-half-inch pots. The soil for the first potting should be a very sandy, porous loam, and if some leaf-mold is added, the cuttings will become better established. The average temperature for the newly rooted and potted small plants should not be below 65° at night. If the temperature is a trifle higher, the growth will be better. When established in the pots, they may be kept at a temperature of 60°.

As soon as the young plants fill the soil with feeding rootlets, they should be re-potted. In later re-potting, some well-rotted manure should be used in the soil, and the amount gradually increased with each re-potting. Great care should be taken in watering the young plants, especially during long periods of cloudy weather.

As the plants develop, they should be given full sunlight and frequently pinched to make them symmetrical. By the last of April, those propagated in November should be in four-inch pots. They should then be kept in a temperature of from 55° to 60° at night, and given abundant ventilation. After the first of May, the glass should be shaded somewhat, or the leaves will burn.

During the latter part of the summer, the plants will begin to make a strong growth for the production of flowers. They will require considerable attention in the way of staking and tying up, but stakes should be used with care, so that the plants will later be symmetrical, and the stakes as inconspicuous as possible. The plants should be gone over frequently, and given sufficient room in which to develop their tops, so that they will not become spindling.

They make their best growth when placed upon inverted pots, for this allows a better circulation of air and light, and the plants are very much more symmetrical.

By the first of September, the shade should be gradually removed and the plants placed in their flowering pots. After they have become thoroughly established, they should be given dilute liquid manure every week. Many growers pick the early flowers to bring them into full bloom at about the same time; others believe that if the first blooms are picked, it hardens the flowering wood, and the later blooms are not as satisfactory.

Plants propagated in November should be large enough for sale the following November. Cuttings may be taken later than November, and grown for Easter sales. The size of the plant is not of so much importance as that the plant be symmetrical and well filled with blooms. Some varieties will not propagate readily from leaf cuttings, — for example, the new variety Mrs. Heal. Those who have grown this plant state that it roots more readily from stem cuttings. In regard to the growth of this variety, William Downs, Superintendent of the Webster Estate, Chestnut Hill, Massachusetts, states that they are much the same as the Lorraine in their habit of growth. They do not make a very vigorous growth until August or September, when they commence to grow rapidly. Downs emphasizes the fact that at no time should they be carelessly watered, for overwatering causes a rotting of the bulbs, which destroys the plants.

To carry the old plants through the winter, it is necessary to give them good care after the flowering season. They should be kept in a temperature of about 50° until spring, and as soon as they begin to show signs of growth, they are re-potted and put in a warmer house. They are then

carried through the summer in the same way as described for other plants in this group.

495. Summer-flowering or tuberous-rooted begonias. — Tuberous-rooted begonias are of less commercial importance than the semi-tuberous group. They are used somewhat for summer sale. They aid in making conservatories and store windows attractive, and in some instances are successfully used for outdoor bedding.

Habitat. — Mostly from Mexico and South America.

496. Propagation. — The tuberous-rooted begonias are grown entirely for summer bloom, and the best plants are produced from two-year-old tubers. They may be secured from the larger seed-houses, and cost approximately six dollars a hundred. For early flowering, the tubers should be started in February or March, in shallow boxes of sandy loam, and in a temperature of 60° to 65°. Tuberous-rooted begonias may be grown from seeds, but they are not as satisfactory the first year as those grown from tubers. Seeds are usually sown in shallow pans in March. The soil should be very finely sifted, and composed of one-half leaf-mold and one-half sandy loam. The seed is very fine and should be scattered thinly, then pressed into the soil, which will be sufficient covering. The pans should be covered with glass and paper for a few days, and kept in a temperature of not less than 70°. As soon as the plants appear the paper should be removed, and when the young plants have roots about a quarter of an inch long, they should be put into boxes of nicely prepared soil.

497. Culture. — As soon as the roots have developed, and the leaves are appearing from the tops of the tubers, they should be potted into three-inch pots. In this potting, considerable well-rotted manure should be added to the sandy loam, and when the root system has become es-

tablished, a temperature of 55° to 60° may be maintained. Care should be taken after potting that too much water is not given the plants, for it causes stems to decay at their base. They should be given a light, airy house, but when the flower buds begin to form, shade should be applied to the glass, and they should be brought into bloom under partial shade. This makes a better coloring of the flowers and also increases their keeping qualities. The plants should be re-potted when necessary, and by the first of June they should be in their flowering pots.

The tuberous-rooted begonias, after becoming well established in three and one-half-inch or four-inch pots, may be planted out of doors for summer bedding, and are very beautiful when placed in a partially shaded and protected spot. The flowers are greatly injured by high winds and heavy rains, also by intense sunlight. They should not be put into the ground until the first of June, or after the soil has become thoroughly warmed.

498. The Rex or foliage begonias.—The Rex begonias are grown principally for their foliage characters. They show a wide variation in coloring, and are excellent for summer window-boxes in protected places, also for conservatory ornamentation. They are more attractive in the summer than at any other time of the year.

Habitat. — India and southern China.

499. Propagation.—Rex begonias are mostly propagated from leaf-cuttings but may be grown from shoot-cuttings. When large numbers are desired, well matured leaves are selected, and sections, each with a strong-veined part, are cut from the base of the leaf and placed in sand in the propagating bed, where they have strong bottom-heat. The roots form quickly, and small plants soon develop from the base of the cuttings. The cuttings

root better in a case where they have a rather confined atmosphere, than in a drier propagating bed.

500. Culture. — As soon as the cuttings are well rooted, they are potted in a light, porous, sifted soil, composed of loam and leaf-mold in equal parts. They should be kept in a low house, and in a moist atmosphere. In the second potting, they should be given a soil composed of one-fourth well-rotted stable manure, and three-fourths loam.

In watering, always avoid wetting the leaf, and as soon as the plants are in five- or six-inch pots, they should be put in a partially shaded house and given abundant ventilation, both day and night. The Rex begonias are more exacting than most other species.

501. The flowering or fibrous-rooted begonias. — Fibrous-rooted begonias are in considerable demand as potted plants. Young plants, well grown, have very attractive foliage and flowering characters. When poorly grown they are spindling and destitute of foliage.

Habitat. — Mostly from tropical and sub-tropical America.

502 Propagation. — The fibrous-rooted begonias are usually propagated from stem cuttings. They may be taken at any season of the year, but the cuttings will root more readily if placed in the sand during March or April. The plants will then be large enough for sale the following winter. It is better to have the cuttings in a propagating case, so that they will not be injured by sudden changes of temperature. They root best in a temperature of 55° to 60°.

503. Culture. — When the cuttings are rooted, they should be potted in ordinary garden loam in which there is little decayed organic matter. Later, the plants may be

potted in three-inch pots, with a soil mixture of three parts fibrous loam and one part well-rotted cow manure. The plants should be exposed to full sunlight throughout the winter and early spring, but during the summer they should be given partial shade, or the foliage will be light yellow. The plants should be pinched frequently to make them symmetrical, and turned often, so that all sides will develop uniformly. They ought never to be pot-bound, but should be re-potted as soon as the soil becomes well filled with feeding roots. Most species may be easily grown as house plants.

Begonia semperflorens is an exceedingly variable species, and there are many varieties. Most of them are dwarf and compact in their habit of growth, and flower when comparatively young. They are excellent for outdoor bedding, and in many cases the foliage colors to rich crimson tints. They are propagated annually by seeds, which are sown early in January. As the seeds are very small, great care is necessary in sowing them. It is better to use pans than flats. As soon as they have developed their second leaf, they should be pricked into flats and kept in subdued light for a few days. The soil for this transplanting should be of a sandy nature, for the begonias are injured by an excess of water in the soil. When they have become well established in the flats, they may be transplanted into two and one-half-inch pots. Later they are repotted in three and one-half or four-inch pots. The begonias should not be planted directly from the greenhouse into the beds, but should be placed for a time in a coldframe, that the plants may become accustomed to outdoor conditions.

OXALIS

504. Botanical classification. — Order, Oxalidaceæ; genus, *Oxalis* (Latin, *Sour*, referring to the usual acidity of the foliage), species, many, but the most important are: *Bowiei*; leaves large, flowers large, bright rose-red; *cernua* var. Bermuda Buttercup; the leaves are deeply notched, and often purplish in color; the flowers are bright yellow and grow in large compact clusters.

505. Botanical characters. — *Oxalis* are bulbous plants with clover-like leaves. Large quantities of flowers of brilliant colorations are produced, but open only in full sunlight.

Habitat. — South Africa and tropical and subtropical America.

506. Culture. — *Oxalis* are grown principally in window baskets or as potted plants. They are excellent for hanging baskets in sunny windows. They should be potted in August or September, in a rich, well-drained, sandy soil and placed in full sunlight. With an abundance of water, growth will be rapid and they continue to bloom for a long period. After they are through blooming, the pots may be dried off and the bulbs will then remain dormant until the following fall. They may then be re-potted and started into growth for a second year.

LILIES FOR FORCING

507. Botanical classification. — Order, Liliaceæ; genus, *Lilium* (an ancient Latin name), species: *longiflorum*, *candidum*, *myriophyllum*, and *speciosum* var. *rubrum*. Important varieties of *longiflorum* are *giganteum*, *multiflorum* and *eximium*.

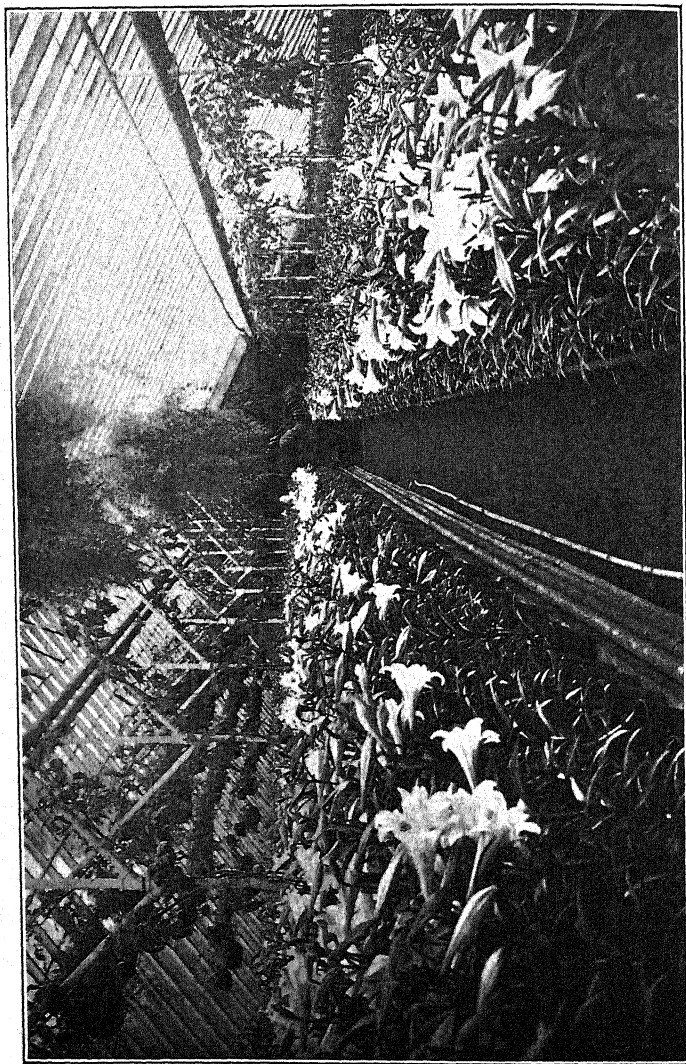


FIG. 38. — A commercial house of Easter lilies.

508. Botanical characters. — Lilies are herbaceous plants with scaly bulbs and an upright stem, more or less densely clothed with narrow, lance-shaped leaves. From the axils of the terminal leaves, or from the tip of the stem, a number of flower-buds are formed. The color of the varieties most generally forced is white. Within recent years, the dark pink variety of *speciosum* has come into favor.

Habitat. — China, Japan and Formosa.

509. Commercial importance. — With the introduction of the practice of cold storage for lily bulbs, the former so-called "Easter lily" has become an all-the-year-round crop. There is a constant retail demand for the flowers, and the culture of the crop is, therefore, profitable (Fig. 38).

510. Importation of bulbs. — Lilies are not difficult to grow under glass, if the bulbs are strong and vigorous. Bulbs are usually imported during August and September, and should be potted as soon as received. Scaly bulbs should never be allowed to dry out. All bulbs should be examined carefully to detect any disease if present. There are three leading commercial grades, measured by the average circumference in inches, namely: five to sevens, seven to nines, and nine to elevens. The price of bulbs varies according to size. The average commercial grower most commonly uses the seven to nine size.

511. Culture. — Lilies which are designed for Christmas bloom should have a soil well enriched with thoroughly decayed stable manure. They should be potted the same as other bulbs, but it is well to set the early bulbs on a cushion of sand. In potting, the lilies should be placed in four-inch pots and shifted to larger ones as the pots become filled with roots. The top of the bulb should be level with the surface of the soil. As soon as the bulbs are potted,

they should be put in frames or in a cool, dark cellar, where root action will start quickly. Those desired for Christmas should be put immediately on benches in a cool greenhouse, and the pots covered with damp sphagnum moss. As soon as the root action is well started, they may be placed in a night temperature of 50°. This may soon be increased to 60°, and later to 75°. The tops should be well developed, and the buds well above the foliage, six weeks before Christmas. The bulbs are not uniform in their flowering habit, and under the same conditions it is not possible to have them all in bloom at one time. The buds should be opening nine or ten days before Christmas, and the plants then placed in a comparatively low temperature to harden them for the holiday trade.

Lilies which are not in flower for Christmas may be brought into flower later, for they are always in demand. Lilies for Easter should be brought into the houses by the middle of December, and forced the same as those for the Christmas sale. If there is a tendency for the stems to be short, the plants may be put in a reduced light, which may increase their length. Lilies designed for summer flowering should be kept in a very cool house until the middle of May, and then given a moderate temperature and an abundance of air, to produce good strong stems and large flowers.

As soon as the buds are well developed, they should be cut, placed in a cool cellar, and allowed to open gradually. Such will have better keeping qualities. If they are desired for fall trade the bulbs are kept in cold storage until about the middle of July, and are then potted and treated the same as the others.

Lilium speciosum var. *rubrum* is especially good for forcing. After the bulbs are potted in July, they should

be placed in a cool cellar until the roots start. They should then be brought into a light, airy house, and given an abundance of water. All lilies need a frequent light fumigation to prevent the attacks of the Aphis.

CALLA LILIES

512. Botanical classification. — Order, Araceæ; genus, *Zantedeschia* (after F. Zantedeschi, Italian botanist); species: *æthiopica*, *melanoleuca*, *albo-maculata* and *Elliotiana*. Some varieties are:

Little Gem, dwarf, very free bloomer; *Godefreyana*, medium in size, more prolific than type; *gigantea*, plant large and vigorous.

513. Botanical characters. — Callas are perennial herbs with many long-petioled leaves rising from a thick rhizome. The peduncle of the flower is as long or longer than the leaves; the spathe large, open, flaring, with a pointed, recurved tip.

Habitat. — Southern Africa.

514. Propagation. — Many small offsets form around the parent rhizome of the calla lily, but they require the growth of several years before they are large enough to produce flowers. The parent rhizomes are long-lived, and seem to improve with age. Yellow callas are now quite popular as novelties or as ornamental conservatory plants. They are difficult to propagate except from seed. Yellow callas are grown in a similar way to white calla, but seem to flourish best without a resting period.

515. Culture. — White calla is a valuable commercial flower, and is grown quite extensively, although the introduction of *Lilium longiflorum* and other species, as all-the-year-round flowers, has lessened somewhat the de-

mand for the callas. Commercially, they are frequently grown in beds, using a very rich soil, and given full sunlight, with an abundance of water, during the growing season. Large flowers are the result. The plants are dried off as summer approaches, and given a season of rest. As a pot plant, the calla is frequently grown as a window plant in dwelling houses, but unless the rhizomes are large, and an abundance of pot room and rich soil are given, it is rarely satisfactory. During the summer, the pots are laid on their sides out of doors and in the shade of trees. They are not allowed to become bone dry, yet kept on the dry side. In the fall, all the old soil is shaken from the rhizome, which is planted in a large pot — about a seven-inch pot — in a rich compost of two-thirds heavy loam and one-third well-rotted cow manure. As soon as the roots are well established, frequent applications of liquid manure are given. They should have strong light, and a temperature of about 55°.

HYDRANGEAS

516. Botanical classification. — Order, Saxifragaceæ; genus, *Hydrangea* (Greek *hydor* — water, and *aggeion* — vessel, alluding to the cup-shaped fruit); species, *hortensis*.

517. Botanical characters. — Ornamental, deciduous shrubs, with simple leaves and small, white, blue or pink flowers in corymbs or panicles, bearing usually sterile flowers, with enlarged showy sepals.

Habitat. — The greenhouse species are native in China and Japan.

518. Commercial importance. — Hydrangeas are important commercially, because of their adaptation to forcing for Easter sales. They are also excellent for Memorial Day. They are grown with comparative ease, and are

pleasing for the home, especially for piazza and lawn decoration. With the introduction of the newer French hybrids, this group of plants has increased in popularity. Among them are Madame Maurice Hamar, Avalanche and Dentelle. A recent introduction of *Hydrangea Sargentiana* from the mountains of Central China seems promising as a cool greenhouse plant.

519. Propagation. — Cuttings may be taken at any season of the year, but if they have a few degrees of bottom heat, roots will form more quickly. If cuttings are taken in January or February, they will make good sized plants for the next season's bloom. As soon as the cuttings are rooted, they should be potted in small pots. *Hydrangeas* should not be allowed to become pot-bound during their growing season, for then they lose their lower leaves and become unsightly.

520. Culture. — Plants intended for Easter bloom should be brought into the house early in January, and cleaned of their old foliage. They should be started in a temperature of about 45°. In about two weeks, the temperature may be raised ten degrees. The plants should be syringed frequently so there will be a uniform development of buds over the entire plant. They may be brought into flower at a temperature of 65°. They should be in full bloom ten or twelve days before Easter, and then removed to a temperature of 50° or 55° to harden the blooms and to increase their keeping qualities. All plants left over from spring sales, and those propagated early in the year, should be planted out of doors by the middle of June. They should be given a rich soil, full sunlight and plenty of water, that a rapid, strong growth may be encouraged. Compact, shapely specimen plants are obtained by a judicious pinching back of fast-growing

branches. After the middle of July, all pruning should be discontinued; but weak, straggling growths may be removed, and only strong, vigorous canes allowed to develop. The plants should be lifted and potted about the last of September.

They should be kept cool and partly shaded for a few days, until well established, and then exposed to full sunlight. After the first frosts, the plants are removed to a cool greenhouse or a cool, light cellar. Here they are kept until it is time to force them into bloom. Specimen plants used for lawn decoration may be stored in a cool, light cellar where the temperature averages about 35° throughout the winter. A strong, vigorous summer growth, and well ripened wood in autumn, are essential for success in growing hydrangeas.

ACACIAS

521. Botanical classification. — Order, Leguminosæ; genus, *Acacia* (an ancient name); the most important species: *armata*, *Drummondii*, *pubescens*, *longifolia* and *Baileyana*.

522. Botanical characters. — Acacias are shrubs with finely divided leaves, or with the petioles of the leaves reduced to phyllodia or leaf-like bodies. The flowers are yellow or white, minute, in globular heads or cylindrical spikes. They are very showy.

Habitat. — Chiefly from Australia.

523. Commercial value. — Acacias have recently become quite popular as Easter plants. Before their cultural environment was understood, they were considered difficult plants to grow, but now they are classed with profitable potted plants.

524. Propagation. — The cuttings root with some difficulty, but if half-ripened wood is taken during June, and inserted in the propagating bench, nearly all of them will root. They should be covered with a close frame to keep the atmosphere moist, and kept cool by shading.

525. Culture. — As soon as well rooted, they should be potted in a sandy loam. Acacias like cool atmospheric conditions, and do not grow satisfactorily when forced. They should be kept in a temperature from 40° to 50° during the winter, and allowed to develop in a natural way during March and April.

The plants have a tendency to become unshapely, and it is well to prune them quite severely, when they are repotted after the flowering season. As soon as all danger of frosts is over, the plants should be plunged out of doors, the pots being buried to their rims in well-drained soil. They will need some attention during the summer, and the pots moved occasionally, so the roots will not come through into the surrounding soil.

As soon as the plants have filled the pots with roots, they should be given weak, liquid manure once a week. An effort should be made to stimulate a vigorous growth during the summer, as it is about the only time when acacias make very much growth. The plants should be brought into a cool house before the first frosts in the autumn, and given plenty of ventilation during the winter months. A house with a northern exposure particularly suits them.

GENISTAS

526. Botanical classification. — Order, Leguminosæ; genus, *Cytisus* (Greek name for a kind of clover); species: *racemosus*, *canariensis*.

527. Botanical characters. — Genistas resemble the acacia somewhat in their general habits of growth. They are low shrubs, bearing three-foliate leaves, and producing in the early spring a large number of yellow pea-shaped flowers.

Habitat. — Canary Islands.

528. Culture. — Cuttings of genistas are started in early spring, re-potted several times, and then gradually hardened off. They may be plunged out of doors for the summer or kept in a cool greenhouse. It is better to keep young plants under glass for the summer, but the older ones will make a satisfactory growth if plunged outside.

In the fall, they should be started at a low temperature, given plenty of light and air, and carefully and moderately watered during the winter months. About the first of January, they may be removed to a house where the temperature is about 55° and then should be well in flower for Easter. After flowering, the plants should be cut back, and re-potted. Genistas may be grown with acacias.

ERICAS

529. Botanical classification. — Order, Ericaceæ; genus, *Erica* (name of no special meaning); species of commercial importance: *melanthera*, flowers from October to February; *Wilmorei*, December to February; *persoluta*, varieties *alba* and *rosea*; February; *gracilis*, October to February; *hyemalis*, January, February and March (Fig. 39); *stricta*, March, April and May; *Cavendishiana*, March and April; *mediterranea*, March and April.

530. Botanical characters. — Ericas are low-growing, much-branched, evergreen shrubs with needle-like leaves, in whorls of from three to six. The branches bear great

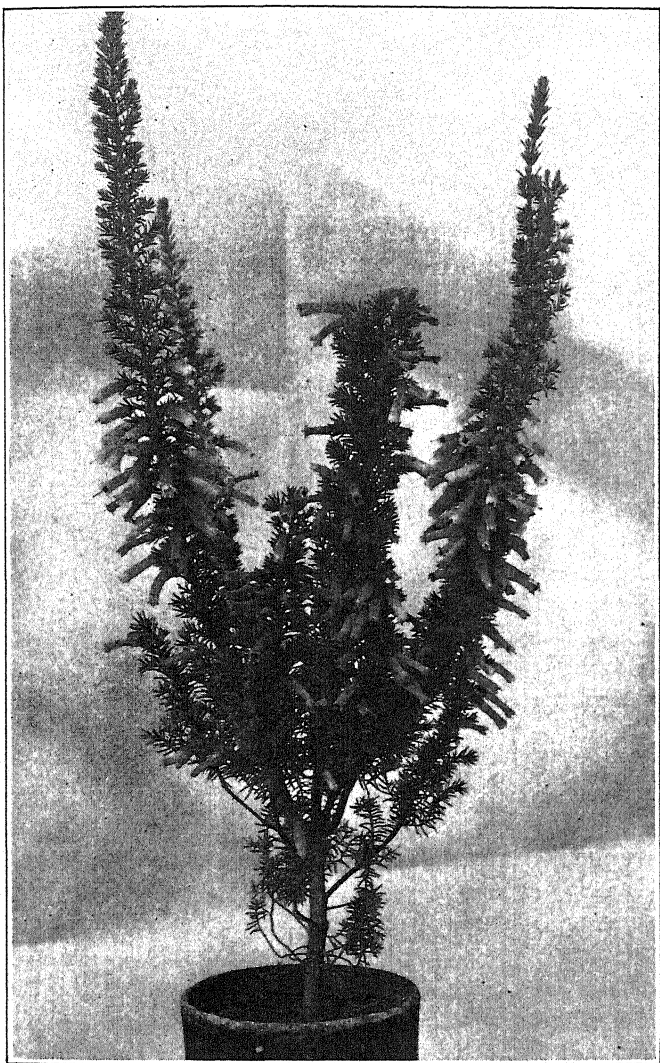


FIG. 39. — *Erica hyemalis*.

numbers of small pink, white or rarely yellow, mostly bell-shaped flowers. A few species have long, tubular flowers swelling at the base and tapering to a narrow neck.

Habitat. — Europe.

531. Commercial importance. — *Ericas* have recently grown rapidly in favor, and are now a most popular spring-flowering plant. They are not difficult to grow, and when properly cared for, make a most satisfactory house plant, having a long period of bloom. Small plants are excellent for table decoration. They supplement cyclamen, primulas and bulbous plants for winter bloom.

532. Propagation. — *Ericas* are propagated from cuttings made from December to April. They should be taken from young plants, where strong shoots about one inch long may be obtained, and planted firmly in a pan filled with clean, sharp sand, and covered with a bell-glass. Bottom-heat is not necessary.

533. Culture. — When rooted, the cuttings are potted in small pots, using a mixture of equal parts of leaf-mold, sifted fibrous loam and sharp sand. When well established, they should be given an abundance of air. As early as possible in the spring, they should be plunged in the cold frames, and later may be plunged in the open ground where they can get full air circulation and sunlight. In the early autumn, they should be brought into a cool greenhouse and re-potted. The soil at this time should be composed of equal parts of fibrous loam of a sandy character and leaf-mold. *Ericas* will not grow in soil in which there is actively decomposing organic matter.

After re-potting, *ericas* are kept partly shaded until the roots are fully established, and then are given full sunlight. They like a low temperature, and the night temperature should not be allowed to go above 50°, while the day tem-

perature should be kept no higher than 60°. The heaths are particular in regard to soil moisture; too much or too little water is injurious to them. The pots need to be gone over carefully each day and kept at just the right degree of moisture. They should never be allowed to wilt, but during the winter months, they require less water than when growing rapidly. After flowering, they should be trimmed into symmetrical forms. Summer pinching is also often necessary to accomplish this. The foliage should not be allowed to drop from the lower part of the stem. Heading them back has a tendency to prevent this.

The plants may be carried through several years, provided care is taken in the summer treatment. They should be re-potted in June each year, and great care taken to keep the root system active. Ericas require abundant ventilation at all times. They are susceptible to attacks of mildew, and if this appears, they should be sprinkled with sulfur. During the summer, great care should be taken that the plants do not dry out.

AZALEAS

534. Botanical classification. — Order, Ericaceæ; genus, *Azalea* (from Greek *azaleos*, *dry*. Linnæus believed them to grow in dry localities); species: *sinensis*, *gandavensis*, *calendulacea*, *Vaseyi*, *indica*. The first four species are hardy. In most of them, the flower-cluster precedes or accompanies leaf development. *Azalea indica* is an evergreen shrub which requires greenhouse cultivation (Fig. 40). Genus often included in *Rhododendron*.

535. Botanical characters. — Azaleas are shrubs with persistent or deciduous foliage. The flowers are produced in showy, terminal clusters. The corolla is five-lobed,

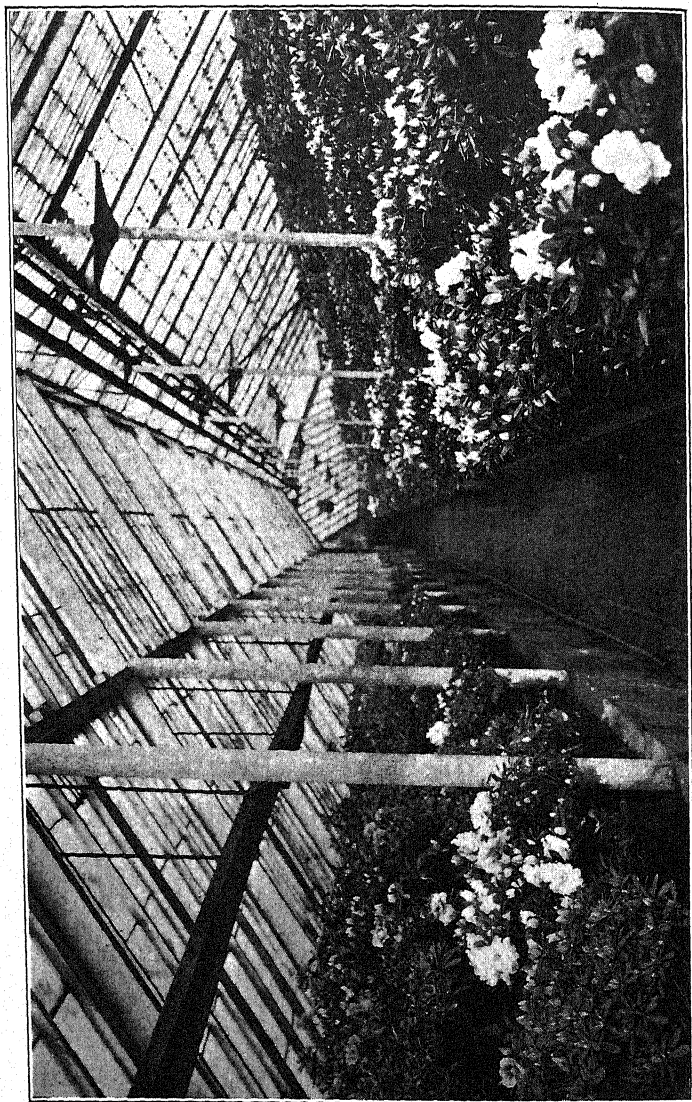


FIG. 40. — A house of *Azalea indica*.

funnel-formed, campanulate or rotate. The stamens are from five to ten, and the ovary is five-celled.

Habitat. — North America and Asia.

536. Commercial importance. — Azaleas are an exceedingly important crop from the flower-growers' viewpoint. The demand for these flowering plants at Christmas and at Easter often exceeds the supply. Large numbers are imported yearly from Holland and Belgium.

537. Culture. — As soon as the importation from Europe is received, azaleas should be unpacked, and each plant having a dry root system should be placed in a tub of water long enough to saturate thoroughly the ball of roots. This is very important; otherwise, the fibrous roots, which have become so shrunken and exhausted of their water supply, will require a long time in which to revive.

Azaleas should be potted immediately into as small pots as possible, using a mixture of equal parts of leaf-mold and garden loam, with enough sharp sand to insure excellent drainage. The azalea is very particular as to its water supply. The soil should never be dry; on the other hand it should never contain enough water to make it stagnant. After the azaleas have been potted, they should be placed in a cool, shaded house, and in rather a close atmosphere. They should be sprayed daily, gradually given increased sunlight, and when well established in the pots, should be given full sunlight, in a cool house well supplied with fresh air. The varieties which are to be held back for Easter should be kept in a temperature of 45° to 50° and those desired for Christmas allowed a temperature of 50° to 55°. This temperature permits the buds to develop gradually, and six or eight weeks before Christmas the plants should be placed in a temperature of 60°

or 65°. Varieties best suited for Christmas are: Firefly, Madame Petrick, Deutsche Perle, Simon Mardner, Apollo and Vervæneana.

By the middle of December, azaleas should be in bloom sufficiently so that they may be again subjected to a temperature of 50° to 55°, to harden them off for Christmas sales. They should be given good ventilation, but kept from cold currents of air, or the flowers will wilt. They require an abundance of water during their blooming period, and when fully in bloom, they should be placed in a cool, somewhat shaded spot.

Plants designed for the Easter sale are given similar treatment. They should be kept in a low temperature until fully in flower, and hardened before sale, the same as the Christmas varieties. During the growing season, azaleas should be syringed frequently to avoid the red-spider, and to keep the atmosphere moist.

The best time for re-potting is after flowering, when the new growth commences. Azaleas should not be neglected at this period, for they are forming the wood, and especially the bud tissue, for the next season's bloom. They should be given plenty of water and good ventilation. When they have become established in the pots, and the weather is warm enough, the pots should be plunged in the soil in some spot which is exposed to full sunlight, and where they can be given water from time to time. They may be planted directly in the soil, provided a bed has been prepared for this purpose. The bed should contain a large amount of leaf-mold. Azaleas are injured by the presence of any decaying organic matter of a heating character in the soil.

POINSETTIAS

538. Botanical classification. — Order, Euphorbiaceæ; genus, *Euphorbia* (classical name); species, *pulcherrima*.

539. Botanical characters. — Poinsettias are shrub-like plants with milky juice. The foliage is attractive. The flowers are yellow and inconspicuous, but the flower-cluster is surrounded by an involucre crown of intense crimson leaves.

Habitat. — Tropical Mexico and Central America.

540. Commercial importance. — Poinsettias are distinctly Christmas plants, and the demand for them is limited to a short season. They are grown in large quantities, and are used for cut-flowers and for potted-plants. Small plants are especially pleasing when used with ferns or other foliage plants.

541. Propagation. — Poinsettias are propagated from cuttings which are taken from April until the middle of August. When the plants are through flowering, the first of January, the stock plants are selected, and placed under the benches for at least ten weeks. Here they are allowed to become dried, but the wood should never shrivel. They should be kept in a temperature of 50° to 60°. About the middle of April, the old soil should be shaken off, and the plants potted in new, rich soil. They are then cut back considerably and placed on a sunny bench where they will get some bottom heat. New growth will start almost immediately, and this furnishes the material for cuttings.

542. Culture. — As soon as the cuttings are rooted, they should be potted carefully so that the roots are not injured. They break easily, and if broken, the vitality of the plants is weakened. A good, fibrous loam, to which has been added about one-fourth the bulk

of well-rotted cow manure, makes an excellent soil for poinsettias.

During the summer, they may be plunged out of doors in full sunlight, or grown in the benches in the greenhouse. If grown under glass they should be given abundant ventilation. They should be re-potted frequently, so as not to become pot-bound. If this occurs, the lower leaves may drop off. Poinsettias should be placed in a cool greenhouse with some bottom heat, but the temperature should never go below 55° at night. As soon as the plants begin to show color, the temperature may be increased 10° or 15°. Care should be taken that the plants do not become dry, and the walks and floors in the houses should be moistened frequently to produce a damp atmosphere.

If the plants show any tendency to become pot-bound, they should be given an application of liquid manure once or twice a week. They should be carefully tied to preserve a straight stalk.

The plants should be fully developed by the early part of December, when a temperature of 65° to 70° at night will not be too high. The stock should be developed several days before Christmas, and the temperature reduced to about 50° to harden the plants for the Christmas trade. Poinsettias in pans or pots should not be over-watered, neither should they be allowed to dry out, or the leaves will become yellow. Poinsettias for pans may be propagated as late as the middle of August. After the cuttings are potted up, they should be shaded for a few days, and syringed frequently. As soon as the new roots have developed, the plants should be placed in full sunlight, and given plenty of ventilation.

The plants should not be put into pans until the last of September or the first of October; other-

wise, they will become too tall to be attractive for the holiday sale. Poinsettias which are to be used for cut-flowers should have the ends of the stems cauterized by dipping them in hot water for a moment before they are put into cold water. Often the ends of the stems are dipped in melted wax to prevent bleeding, but this interferes with the absorption of water, and the plants do not have the keeping qualities which they have if hot water is used.

After they are cut, they should be kept in a temperature of 45 ° to 48 ° for twelve or eighteen hours before they are put on the market.

GARDENIAS

543. Botanical classification. — Order, Rubiaceæ; genus, *Gardenia* (after Alexander Garden, M.D., of Charleston, S.C.); species, *jasminoides*.

544. Botanical characters — Gardenias are shrub-like plants with dark green, evergreen foliage and large, waxy white, fragrant flowers.

Habitat. — China.

545. Commercial importance. — Gardenias were among the earliest cut-flowers grown under glass in America. For many years they were in demand, but with the introduction of roses and carnations, they became less popular. Within recent years, however, they have again come into public favor, and are now grown extensively in pots and in beds for winter flowering.

546. Propagation. — Gardenias are propagated by cuttings taken in December and January. They should be given a bottom heat of not less than 75°, and the atmosphere kept close, until they have calloused, when they may be given more air.

547. Culture.—Cuttings made in December and January make the best stock plants for planting in the house during May and June. The soil best suited to the young stock is a turfy loam, enriched with about one-fourth its bulk of well-rotted cow manure. Some sand should be added to give good drainage, and great care should be taken to pot the cuttings firmly. The young plants should be placed near the glass and in a temperature of 65° to 68° at night. The air should be kept pure, but free from chilling drafts. Nothing should retard the growth of gardenias during their growing season.

By the first of March, the plants should be in four-inch pots, and not again re-potted, but planted in benches in June. Atmospheric conditions play a most important part in the healthy development of gardenias. The walks should be dampened several times a day, especially during the hot days of late spring. The soil should be carefully watched, and never allowed to become too wet or too dry.

When planted in benches, a good compost for the soil is three parts of very fibrous loam with one part of well-rotted stable manure. If the soil is heavy, some clean sand should be added to make it porous. Excellent drainage facilities should be provided for the benches, for imperfect drainage causes the foliage to become yellow. The plants should be set about sixteen inches apart. During the summer, they should be given very careful attention. They are injured if the temperature falls too low on cold nights, and by the twentieth of August it is best to have heat available, so that a night temperature of about 65° may be maintained. The atmosphere should be pure, however, and it may be necessary to leave the ventilators open part of the time.



FIG. 41.—*Ardisia crenulata*.

To have the most healthy growth, the ventilators should be opened gradually during the morning, and closed in the same way in the afternoon. Care should be taken not to over-feed the plants during the dark, cloudy weather in November and December. If given too much manure water at this season, they may drop their buds. If the growth appears weak, an occasional light watering may be beneficial.

ARDISIAS

548. Botanical classification. — Order, Myrsinaceæ; genus, *Ardisia* (*pointed*, referring to the stamens or corolla lobes); species: *crenulata*, red-berried; *japonica*, white-berried (Fig. 41).

549. Botanical characters. — *Ardisias* are shrub-like plants with thick evergreen leaves, white or pink, rather inconspicuous flowers and showy red or white fruits.

Habitat. — East India, China and Japan.

550. Commercial importance. — *Ardisias* are extensively grown for the Christmas trade. The red-berried species is more popular than the white-berried. The rich red berries, contrasted with the dark, glossy green foliage, make them especially attractive.

551. Propagation. — *Ardisias* are usually grown from seed which should be sown early in the spring, if glossy foliage and well-colored berries are desired for the Christmas trade. *Ardisias* may be propagated by cuttings of half ripened wood, taken in the early spring. They root with difficulty, however, and propagation by seeds is the most satisfactory method.

552. Culture. — They grow well in almost any potting soil, but should never be allowed to become pot-bound or dry, for this causes the plants to lose their lower leaves

and become unsightly. They grow best in a night temperature of about 50°. The crop of berries will remain on the plant for more than a year if the plants are grown in a cool temperature, and frequently two crops of ripe berries may be seen on the same plant. During the fall, the plants should be exposed to full sunlight, and turned slightly from time to time so that the growth will be symmetrical.

SOLANUMS OR JERUSALEM CHERRIES

553. Botanical classification. — Order, Solanaceæ; genus, *Solanum*; species: *Pseudo-Capsicum*, *Capsicastrum*.

554. Botanical characters. — *Solanums* are low, shrub-like annual plants, with shiny green leaves, and small white flowers, which are followed by large scarlet or yellow fruits.

Habitat — Tropics.

555. Commercial value. — *Solanums* are in considerable demand as potted-plants for Christmas sale. They are easily grown but are less attractive than *ardisias*, both as to habit of growth and color of fruit.

556. Propagation. — The seeds of *solanums* should be sown in January in order to have the fruits well advanced before Christmas.

557. Culture. — By the first of June, they should be in four-inch pots, and may then be planted in open ground, and given careful cultivation throughout the summer. By the last of August, they may be lifted, and planted in a five- or six-inch pot, in soil consisting of three parts fibrous loam and one part well-rotted cow manure. Careful attention should be given to drainage, for the plants are injured by too much water in the soil. For a few days

after the potting the plants should be given shade, but later may be exposed to full sunlight without injury.

558. Other plants with attractive fruit are *Aucuba japonica* and Christmas peppers. *Aucuba* has rather large, glossy leaves, and good-sized red berries. It is usually propagated by cuttings. There is a variegated variety with attractive foliage. Christmas peppers are dwarf plants with small, red, pepper-like fruit. Their propagation and culture is quite similar to Jerusalem cherries.

CHAPTER XVI

FOLIAGE PLANTS

FOLIAGE plants are grown largely for the effectiveness of their leaf characters. As a rule, the flowers are inconspicuous and of little value. The plants are principally natives of tropical countries, therefore, they require a comparatively high temperature. They are, for the most part, shade-demanding, but a few species require considerable light for their best development.

The principal plants in this class are ferns, palms, pandanus, aspidistra, araucaria, cordyline, dracæna, caladiums, crotons, smilax and asparagus (Fig. 42).

FERNS

559. Botanical classification. — Order, Filicales; genera, about 120. The most important genera are: —

Cyathea	Pellæa
Dicksonia	Pteris
Cibotium	Lomaria
Alsophila	Thamnopteris
Platynerium	Asplenium
Nipholobolus	Polystichum
Polypodium	Cyrtomium
Phlebodium	Nephrolepis
Adiantum	Davallia

The species are listed under the different genera.

560. Botanical characters. — Ferns vary much in size, but have similar characteristics. With the exception of



FIG. 42.—A conservatory filled mostly with foliage plants.

the tree ferns, most of the fronds spring from underground rhizomes. They are rapid growers and quickly fill the pots, therefore it is necessary to re-pot frequently. Because of this system of dense underground stems, young plants are more satisfactory than older ones. The frond characters are usually heavy and ornamental.

Habitat. — There are about 4000 species, widely distributed throughout all countries.

561. Propagation. — Ferns are propagated by four methods: spores, bulblets, division, and runners or offsets. The principal method of reproduction is by spores. A few species, however, will not reproduce by spores, and, therefore, other methods must be employed. Spores are usually formed on the back of the fronds in large numbers. When mature, these are collected in paper sacks and allowed to dry for one or two weeks before sowing. The soil for sowing spores should be of a light, porous character, composed of equal parts garden loam and leaf-mold, with sand enough for drainage, and should be finely sifted. The spores are usually sown in pans, but when large quantities are propagated, flats are used. Considerable drainage is placed in the bottom of the pans, and the remainder is filled with soil. It should be moistened thoroughly and the spores scattered evenly over it, then covered with a glass. The glass should remain in position until the sporelings have germinated. When they have developed their second leaf, they should be pricked into flats, using a soil composed of equal parts leaf-mold and sand.

The pan should be kept in a temperature of 55° to 60°. Most varieties are easily propagated in this way, and when potted into two and one-quarter-inch pots, make excellent plants for fern dishes.

To increase certain other varieties, it is necessary to divide the crowns. Among such are *Adiantum Farleyense*, and *Adiantum Croweanum*. The crowns are broken into minute pieces and placed in a pan of live sphagnum moss. The pan is covered with glass and kept in a temperature of 65° to 70°. As soon as the eyes have developed one or two fronds, they are potted and placed in a heavily shaded house. They should be given excellent air circulation, but the atmosphere should be constantly moist and even. Extremes of heat or moisture should never occur. Some species, as *Asplenium bulbiferum*, produce bulblets on the pinnæ of the fronds. These may be separated and placed directly into pans or small pots.

The many varieties of *Nephrolepis* reproduce readily from runners, or offsets; and this is the most common method of propagation. As soon as bedding plants or violets are out of the house in the spring, ferns may be planted in the benches or beds. Within a short time, a large number of runners will be formed, and each one will produce a small plant. After they have developed a number of fronds and a good root system, they may be cut from the parent and potted separately. These offsets make a rapid growth, and are desirable plants for fall sale.

562. Tree ferns. — Included in tree ferns are *Cyathea*, *Dicksonia*, *Cibotium* and *Alsophila*. The characters and culture of these are similar.

563. *Cyathea*, botanical classification. — Order, *Cyatheaceæ*; genus, *Cyathea* (Greek, meaning a *cup*, alluding to the cup-shaped indusia); species: *medullaris*; *dealbata*; *Burkei*; *meridensis*.

564. *Cyathea*, botanical characters. — *Cyathea* comprises a family of beautiful ferns of majestic dimensions. They vary much in their character and size, but all have

large fronds which have numerous pinnæ and pinnules. On the back of the fronds are globose indusia, which rupture at the top and become cup-shaped.

Habitat. — New Zealand and South Africa.

565. Propagation and culture. — Propagation is by spores. Cyatheas are of the easiest culture, but are particular as to temperature and moisture conditions. They require an abundance of water both at the roots and along the trunk, which means frequent waterings and syringings. They should be kept growing vigorously, and should send out a new whorl of fronds frequently. These fronds should be of a large size and rich green in color. They require little pot room and should never be over-potted. If placed in a lath house, for the summer, they will make a more vigorous growth during the winter. They like full sunlight, and the soil should be equal parts of leaf-mold and well-rotted sod. Add to this about one-twelfth of the bulk of well-rotted cow manure and a three-inch pot of bone-meal to one bushel of soil. Compost this about two weeks before the ferns are re-potted.

566. Dicksonia, botanical classification. — Order, Cyatheaceæ; genus, Dicksonia (after James Dickson, an English botanist); species, two, *antarctica* and *squarrosa*.

567. Dicksonia, botanical characters. — The native ferns of the genus *Dennstædtia*, the "hay ferns," were formerly classified as dicksonias. Dicksonias are correctly tree ferns which are larger and heavier than cyatheas. They are hardier and stand a much cooler temperature. The trunks are covered with dense fibers and hold large amounts of water. They have a two-valved indusium.

Habitat. — Australia, Tasmania, New Zealand and Chatham Island.

568. Culture. — Dicksonias make their most rapid growth during the summer, and a new whorl of from thirty to forty fronds is produced each year. They must be carefully watched and watered freely, for neglect in this respect will quickly ruin a plant. Watering is more important than any other detail. In summer, the stems must be syringed at least twice a day. In winter, the waterings should be less frequent. If grown in pots, these should not be large in proportion to the size of the trunks, for they like a confined root area.

569. Cibotium, botanical classification. — Order, Cyatheaceæ; genus, *Cibotium* (Greek, meaning a *little seed vessel*); species: *glaucum*; *Barometz*; *Schiedei*; *regale*.

570. Cibotium, botanical characters. — *Cibotium* have heavier, more unusual trunks than other tree ferns, and the foliage is light yellow-green.

Habitat. — Hawaii, China and Mexico.

The culture is the same as for cyathea and dicksonia.

571. Alsophila, botanical classification. — Order, Cyatheaceæ; genus, *Alsophila* (Greek, meaning *grove-loving*); species, *australis*.

Habitat. — Australia.

The botanical characters and culture are similar to *Cyathea*.

572. Stag-horn ferns, botanical classification. — Order, Polypodiaceæ; genus, *Platycerium* (Greek, *broad horn*, alluding to the shape of the leaves); species: *Angolense*; *biforme*; *Wallichii*; *grande*; *Willinckii*; *alcicorne*; *æthiopicum*; *Hilli*.

573. Botanical characters. — The stag-horn ferns are a peculiar class which have two types of fronds, the barren and the fertile. The barren are disk-shaped and clasp the tree trunks on which they are growing, or cover the soil of

the pot closely; the fertile are upright or drooping, and are cleft at the tip, resembling the antlers of a deer. The sterile fronds are sometimes slightly cleft. With the exception of *alcicorne*, all species are tropical. *Alcicorne* is, therefore, the easiest to cultivate, and is the most frequently seen. The spores are produced in great numbers in irregular patches on the upper or under sides of the forked fronds. In their native habitats, these ferns grow mostly on the trunks of trees, and the abundance of sterile fronds often forms immense clusters

Habitat. — Western Africa, Java, North Australia and Malay Peninsula.

574. Culture. — Stag-horn ferns are most frequently seen in conservatories but are often grown commercially. If their character is understood, they are not difficult to grow; being epiphytes, they will not tolerate heavy soil nor much water at the roots. They require a humid atmosphere, but the humidity should be reduced during the winter. They grow excellently on the trunks of tree ferns. A mixture of one-half peat soil, one-fourth charcoal, and one-fourth chopped sphagnum moss is first bound firmly about the root system. The trunks of the ferns are then wrapped in sphagnum and the stag-horn ferns bound to these with copper wire. After the sterile fronds have gained a foothold, all that is necessary is to add a little more sphagnum moss each year. When once established, they should remain undisturbed indefinitely. If not grown on the trunks of other ferns or palms, they may be attached in the same way to a board or log. Select some durable wood, such as cypress or cedar, and bind on a layer of sphagnum moss. The plant is then attached to the board by copper wire. If grown in pots, the pots should be nearly full of broken pots or charcoal, then filled

with osmundine with a cone of live sphagnum moss on top. They are all tropical, therefore they should nearly all be given an average night temperature of 60°. *P.-alcicorne*, however, endures a lower temperature and is not injured by a night temperature of 50° or even less.

The variety *alcicorne majus* is more attractive in every way, and is preferable to the type. It will endure a drier atmosphere. While all stag-horn ferns require a very humid atmosphere, they should not be syringed too heavily in winter or the foliage will blacken and spot, especially the sterile fronds.

575. Niphobolus, botanical classification. — Order, Polypodiaceæ; genus, Niphobolus; species, *Lingua* var. *corymbifera* and *variegata*.

576. Niphobolus, botanical characters. — Niphobolus is a leathery-leaved species with fronds four to six inches long, from one to six inches wide, and having the tips much branched or twisted. The fronds are dark-green above and densely coated on the lower side with a closely-matted, cottony, rusty down. The variety *corymbifera* is more commonly grown than the type species.

Habitat. — Northern India and Japan.

577. Propagation and culture. — Niphobolus is one of the most easily cultivated species. While growth is free, it may be somewhat uneven and unsightly. It requires the usual soil conditions, but will grow in a lighter soil than most species. It may be propagated rapidly by division of the root-stock just below the surface of the soil, and also by spores. The leathery character of the leaves, and the abundance of rusty down on the back of the fronds, prevent a rapid transpiration of moisture, so that less water is required.

578. Polypodium, botanical classification. — Order, Polypodiaceæ; genus, Polypodium (Greek, *many feet*, referring to the extensive root-stocks); species, about 12, of which *vulgare*, the native polypodium or rock brake, is the most common. The species most commonly grown under glass are *polypodioides*, and *subauriculatum*.

579. Polypodium, botanical characters. — Polypodium is a genus with naked, round sori, the fronds jointed to the rootstocks, where they leave a scar when they drop off. The fronds are entire or once pinnate.

Habitat. — Throughout North and South America.

580. Culture. — Polypodiums are best grown in shallow soil. They are almost epiphytal, and most species will grow well in shallow soil or on trunks of trees.

581. Phlebodium, botanical classification. — Order, Polypodiaceæ; genus, Phlebodium (Greek, *a vein*, referring to the prominent veins); species, *aureum*.

582. Phlebodium, botanical characters. — Phlebodium is a genus closely related to Polypodium, and confused with it in trade. The characters are similar, the difference being in the veining of the frond and the way in which the sori are borne on the veins. *Phlebodium aureum* is one of the larger ferns and is frequently seen in conservatories and commercial greenhouses, being grown for its attractive coloration. The fronds are two to three feet long, blue-green in color, and bear on the back numerous large yellow sori. There are several varieties.

Habitat. — Tropical America.

583. Culture. — Phlebodium grows excellently when planted directly in the soil among palms and other ferns, and the fronds are excellent to use with flowers for large bouquets. A soil composed of equal parts leaf-mold and chopped sod, with a little well-rotted cow manure, suits it

exactly. It grows best in rather large pots, which should have excellent drainage.

584. Maidenhair ferns, botanical classification. — Order, Polypodiaceæ; genus, *Adiantum* (Greek, *unvetted*, referring to the delicate character of the fronds); species, about 40. The most important are: *caudatum*; *curvatum*; *hispidulum*; *macrophyllum*; *trapeziforme*; *intermedium*; *formosum*; *novæ-caledoniæ*; *tenerum*; *excisum*; *cuneatum*; *Wagneri*; *villosum*; *Farleyense*; *gracillimum*; *bellum*; *Moorei*; *Capillus-Veneris*; *Croweanum*.

Habitat. — Largely tropical, of wide distribution. A few are native of the temperate zone.

585. Propagation. — Propagation is by runners from tips of fronds for *A. caudatum*; by division of the rootstocks for *hybridum*, *Croweanum* and *Farleyense*. The others are propagated by spores.

586. Culture. — Most of the maidenhair ferns are easily cultivated. One of the easiest to grow and the hardiest and most compact variety is *Croweanum*. It is the one most used in commercial work, the fronds being utilized in designs or bouquets. *Croweanum* makes an excellent house plant, as do also *curvatum* and *hispidulum*; *Capillus-Veneris* is also easily grown. One of the most popular species, and one most difficult to grow, is *Farleyense*. It requires an even temperature of 70° to 75°, and a light, airy location. Too much moisture in the air is injurious. The fronds are very easily injured, and because of their drooping character, the plants should be set on inverted pots and given an abundance of space. The other species are comparatively easy to grow. They all require a rich loam soil, mixed with one-half leaf-mold. They like a partly shaded location and a moderately moist atmosphere. When grown as house plants a north

window best suits adiantums. They should be re-potted frequently. It is better to discard very old plants and have a succession of young plants to replace them.

587. Pellæa, botanical classification. — Order, Polypodiaceæ; genus, Pellæa (Greek, *pellos* — dusky, from the dark colored leaf stalks); species. *rotundifolia*; *hastata*.

588. Pellæa, botanical characters. — Pellæa is a genus of ferns which are naturally rock dwellers. The sori form around the margin of the pinnule, which rolls under, forming a false indusium. It is of comparatively little value except for planting in fern dishes.

Habitat. — North and South America, Africa and New Zealand.

The culture is the same as for adiantums.

589. Pteris, botanical classification. — Order, Polypodiaceæ, genus, Pteris (Greek name for *wing*, alluding to many pinnate forms), species several, the more common ones being: *cretica*; *serrulata*; *ensiformis*; *quadriaurita*; *tremula*; *Wimsettii*; *adiantoides*.

There are many varieties of each species. *Pteris hastata* of the trade is botanically *Pellæa hastata*.

590. Pteris, botanical characters. — Pteris is one of the most common forms of conservatory ferns and embraces a wide range of characters. They are all characterized by having the sori formed at the ends of the veins, and the margin of the pinnule rolled over, forming a false indusium. They are excellent house plants, and most of the species are suited for fern dishes.

Habitat. — Widely distributed throughout tropical countries.

591. Culture. — The genus Pteris contains ferns which are most easily grown. They are easily propagated by

means of spores. Pteris are not particular regarding soil characters, but grow best in a moderately heavy loam. They should be frequently re-potted and kept in a vigorous condition of growth. When they become old and unsightly, they should be thrown away and replaced by young plants.

592. Lomaria, botanical classification. — Order, Polypodiaceæ; genus, Lomaria (Greek *loma*, seam or edge); species: *gibba* and var. *platyptera*.

593. Lomaria, botanical characters. — Lomaria are rather coarse ferns, mature specimens usually having a short trunk like the tree ferns. The sori are arranged in lines parallel to the mid-rib and the margin of the pinnæ. This is one of the most distinct and symmetrical ferns grown. When young, they are good for table decoration, and when larger, make excellent house plants.

Habitat. — New Caledonia.

594. Culture. — Lomaria require rather a rich soil of one-half leaf-mold, one-fourth well-rotted cow manure and one-fourth loam. They need a quantity of water, and at no time should they become very dry, but should be well drained. They make an abundance of roots and should never be allowed to become pot-bound. When this occurs and the plants have attained considerable size, they may be root-pruned and so kept in smaller pots. Abundant water and bottom heat are then required for a little time, until the new root system has become established. The lomarias should never be given strong sunlight and the temperature should be 65° or 70°.

595. Aspleniums, botanical classification. — Order, Polypodiaceæ; genus, Asplenium (Greek, *not the spleen*, referring to supposed medicinal properties); species, *nidus*, often given as *nidus avis*, *bulbiferum* and *cir-*

cutarium. This last species is advertised in trade catalogues as *Sitalobium circutarium*.

596. Aspleniums, botanical characters.—*Asplenium* is a genus having variously divided fronds. The sori are elongated, covered with a thin indusium and are usually four on one side of a vein. The bird's-nest fern is a species of simple-leaved ferns growing in crowns. The elongated indusia are in parallel rows on the veins of the large, shining, bright green fronds. Often the fronds grow three or four feet long, and are from three to nine inches wide.

Habitat.—Widely distributed from the Alpine sections of northern Europe to the tropics. Several are native in Japan and the East Indies.

597. Culture.—*Aspleniums* are easily grown. They like abundant soil water, but will turn brown, especially in winter, in a moist atmosphere. The glass should be slightly shaded. Propagation is by spores; and in *A. bulbiferum* by bulblets. They are small plantlets which develop on the edge of the pinnæ. When the bulblets are large enough they are removed and firmly planted in a mixture of garden soil, leaf-mold and sand. The small ferns are then placed in a moist, close atmosphere, and in a short time roots will develop and growth will then be rapid. The bird's-nest ferns have become very popular commercially. They are easy to grow and are well adapted to living-room conditions. The clean, glossy foliage makes them especially attractive. They like a soil composed of one-half leaf-mold and one-half well-rotted sod loam. They should have excellent drainage or the foliage discolours. Avoid filling the crown when watering, or the leaves will decay at the base. They will endure a wider variation of temperature than many

species, but a night temperature of 55° to 60° best suits them.

598. Polystichum (commonly called Aspidium), **botanical classification.** — Order, Polypodiaceæ, genus, Polystichum (Greek, *many rows*, referring to the sori); species: *setosum* and *coriaceum*. Many of the species have a densely setose stem, especially near the base. There are several native species, the best known of which is *P. acrostichoides*, the Christmas fern.

599. Polystichum, botanical characters. — Polystichum is a genus of ferns having rather coarse, leathery fronds. The sori are rounded and covered by a peltate indusium which is attached by a stalk to the central vein. They are easily grown and thrive best in shade. Most species are adapted for growth in living-rooms and make excellent house plants. When young, they are excellent for fern dishes.

Habitat. — Europe.

The culture is similar to pteris.

600. Holly ferns, botanical classification. — Order, Polypodiaceæ; genus, Cyrtomium (Greek, *a bow*, referring to the curved character of the sori); species: *falcatum*, *caryotideum*, and its variety *Rochfordianum*, and *Fortunei*.

601. Holly ferns, botanical characters. — The holly fern has once pinnate fronds, the pinnæ with entire or deeply-toothed margins. The texture of the frond is heavy, leathery and very shiny. The round fruit dots are variously scattered over the back of the pinnæ. The base of the stipe is more or less densely coated with setæ.

Habitat. — Asia.

602. Culture. — The holly fern group contains very valuable commercial plants. They are easily grown, and because of the dark green, glossy character of the foliage,

they make excellent house plants. When small, they are particularly nice for fern dishes. The culture is the same as for aspleniums. This genus is closely related to the polystichums.

603. Sword ferns, botanical classification. — Order, Polypodiaceæ; genus, *Nephrolepis* (Greek, meaning *kidney* and *scale*, referring to the shape of the indusia); species: *exaltata*, *cordifolia*, and *davallioides*. The most common types of *N. exaltata*, with their dates of introduction, are as follows:

American origin:

Nephrolepis exaltata, short compact fronds.

var.	Year	Date
<i>bostoniensis</i>	.	unknown
Whitboldi	.	1900
Hilda Fruek	.	1900
Anna Foster (Fosteri)	.	1902
Piersoni (Gold Medal Fern)	.	1903
elegantissima (Philadelphia Lace Fern)	.	1904
Barrowsii	.	1905
Whitmanni (Ostrich Plume Fern)	.	1906
robusta	.	1907
Amerpholi (Filagree Fern)	.	1907
Goodii	.	previous to 1907
magnifica	.	1908
superbissima (Fluffy Ruffles Fern)	.	1908
Elberti	.	1908
Giatrasii	.	1908 (?)
Scholzeli	.	1909
W. K. Harris (Harrisii)	.	1909
Scottii	.	1909 (?)
elegantissima compacta	.	1909
Preussneri	.	1909
Galvestoni	.	1909
Roosevelt	.	1910
viridissima	.	1911
muscosa (Moss Fern)	.	1911
splendens (Big Four Fern)	.	1914
Teddy Jr.	.	1914
Whitmanni compacta	.	Unknown
Smithii	.	1914 (?)

English origin ·

<i>grandiceps</i>	1890
<i>Westoni</i>	1903
<i>superba</i>	1910
<i>superba spiralis</i>	1906 (?)
<i>todeaoides</i> (London Fern)	1906
<i>exaltata superba</i>	1907
<i>Mayn</i>	1906
<i>lycopodioides</i>	1909
<i>Marshalli</i>	1909
<i>Marshalli compacta</i>	1911
<i>Wilmottae</i>	1912
<i>Millsii</i>	1912

604. Sword ferns, botanical characters. — The sword fern is a small genus of subtropical ferns having pinnate fronds. The family shows wide variation, and the varieties of *exaltata* are especially numerous. The variations take the form of subdivisions of the pinnæ, making peculiarly crested or feathery forms.

Habitat. — Florida to Brazil, New Zealand and Java.

605. Propagation and culture. — Propagation is by runners and spores. Sword ferns are very easily grown and make excellent house plants. They adapt themselves to a wide range of conditions, and will do equally as well on a living-porch in summer as in a living-room, provided they are accustomed gradually to the change of conditions. When growing rapidly, the tips are easily injured, and the plants should be so placed that they will not be brushed against. Any good garden loam, with one-third well-rotted manure or compost, makes an excellent soil for them. It should be mixed several days before the potting is done, that all heating caused by fermentation may be avoided, as decomposing organic matter injures the roots seriously. It is rarely wise to keep old ferns, although some specimens do not become unsightly

with age. Keep an active growth all the time, not allowing the plants to become pot-bound. Many finely divided varieties require full sunlight for their best development.

606. Hare's-foot ferns, botanical classification. — Order, Polypodiaceæ, genus, *Davallia*; species *bullata*; *fijiensis*; *dissecta*; *divaricata*; *pentaphylla*; *epiphylla*.

607. Hare's-foot ferns, botanical characters. — *Davallia* is a genus characterized by having distinct root-stocks which creep over the surface of the soil, or are procumbent. The fronds are mostly small and finely cut, giving a graceful appearance to the plant. They are used for hanging baskets and the root-stocks are often bound over sphagnum moss by the use of copper wire. They are then sold, while dormant, as fern balls or baskets.

Habitat. — Java, China, Japan, Australia.

608. Propagation and culture. — Propagation is by division and by spores. *Davallias* are always better when grown in shallow pans. They should be potted firmly in a compost of one-half chopped sphagnum and one-half leaf-mold, with some charcoal, and kept in a temperature of 60° to 65°. The pots should be turned frequently to insure symmetrical plants, and kept in a light, airy spot. They do well when suspended from the sash-bars. They require abundant syringing every bright day.

PALMS

609. Botanical classification. — There are about 130 genera and 1000 known species of palms, but comparatively few are found in greenhouses (Fig. 43). Among the principal genera and species are:—

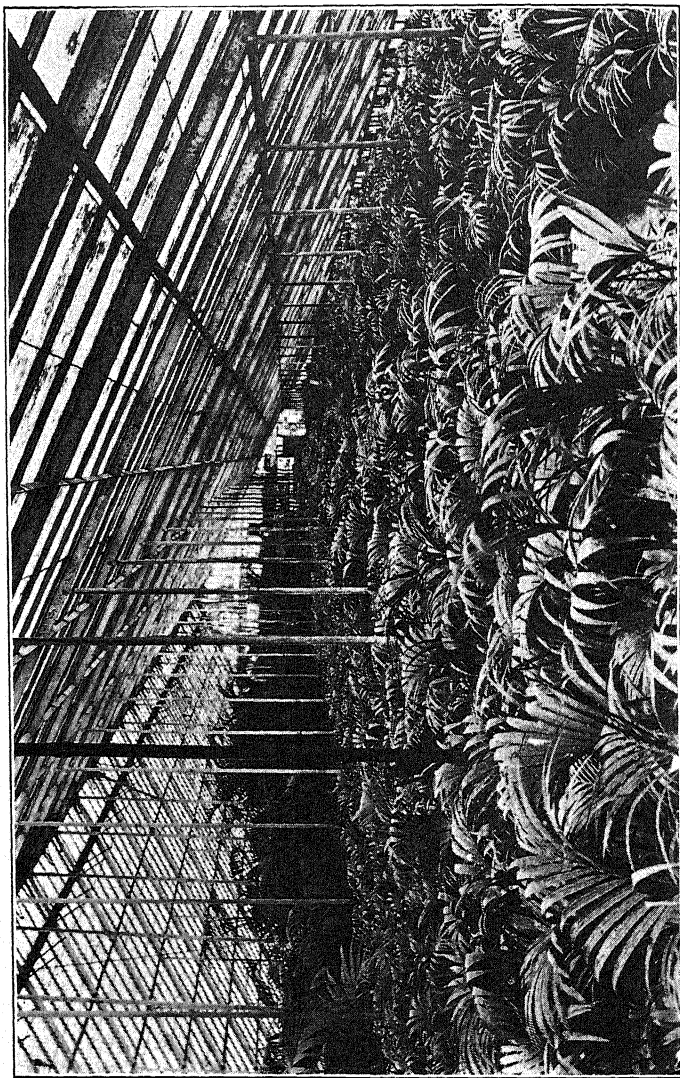


FIG. 43. — A commercial palm house.

Phoenix canariensis.
Phoenix dactylifera, date palm.
Phoenix Ræbelinn, *P. rupicola*.
Chamærops elegans.
Washingtonia filifera, thread palm.
Rhapis flabelliformis, rattan palm
Seafortia elegans
Livistona chinensis, (*Latania borbonica*) fan palm.
Livistona rotundifolia, round-leaved fan palm.
Livistona australis.
Cocos Weddelliana
Caryota urens, fish-tail palm.
Howea (Kentia) *Belmoreana*, curly palm.
Howea (Kentia) *Forsteriana*, thatch palm.
Chrysalidocarpus lutescens, areca palm.

610. Botanical characters.—The attractive foliage of palms makes them very valuable for church, hall and house decoration, and their vigor makes them easy of cultivation. They have striking and unusual flowering habits, but flowering occurs only when they reach maturity. As the trunk rises, the lower leaves fall, so there is only a tuft of leaves at the top.

Habitat.—Mostly in tropical America, but a number of species are African. The sabals and palmettos of the South extend as far north as North Carolina.

611. Propagation.—Most varieties of palms are propagated from seed. The seeds germinate rather slowly, so that it takes six months or more for the seedlings of many species to form the first two leaves. Others germinate in one or two weeks. The seeds are imported at different seasons of the year; the howeas, during July and August; the livistonas, in January; the areca, in February. The seeds cost from fifty cents to two dollars a hundred, depending on the abundance of the seed crop or the scarcity of the species. They are received packed in cocoa-fiber and should be sown at once. One-half finely

sifted leaf-mold and one-half sand makes an excellent medium for seedlings. The seeds are placed in flats and covered about one-half inch deep. If possible, the flats should be placed where they will get a bottom heat of about 80°. The seeds should be kept moist at all times.

612. Culture.—Palms object to having their root system disturbed, and seedlings should not be transplanted until they have developed their second leaf. They may then be put into three-inch pots. The soil should be two-thirds rotted sod, and one-third well-rotted cow manure. Never use commercial fertilizers for palms. The soil should be mixed several days before potting. There should be an abundance of drainage in the pot, for palms will never grow in wet, undrained soil.

Seedling palms look alike, and do not show their characteristic leaf divisions until the third or fourth leaf. They may then be a year or more old. Pots in which palms are grown should be kept clean. The plants should not be re-potted unless absolutely necessary, and then large pots should not be used. Palms have few fibrous roots and require little pot room. Some species may be root-pruned, that they may be kept in smaller pots. Palms should be re-potted during the early spring, just before rapid growth begins, and they should be potted firmly. In re-potting, set the base of the palm level with the soil. As growth develops, this will become elevated, but it is a provision of nature to keep the stem from rotting off. Water should be given abundantly during the season when palms are making rapid growth, but from November to March it should be given sparingly. The plants should not be set in jardinières with water in the base. They should be given an abundance of air during the summer, and kept partly shaded at all seasons, or they will lose

their dark green color. The walks in the palm house should be wet down several times daily to maintain a moist atmosphere. The temperature should rarely go below 60° at night. The foliage should be kept free from dust and dirt.

OTHER FOLIAGE PLANTS

613. Aspidistras, botanical classification. — Order, Liliaceæ; genus, *Aspidistra* (Greek, a *small round shield*; referring to the shape of the stigma); species, *lurida*.

614. Aspidistras, botanical characters. — The aspidistra is a very popular foliage plant, because of its hardy habit of growth and its stiff, shining foliage. The flowers are very inconspicuous, and are borne close to the ground.

Habitat. — China.

615. Propagation. — Aspidistras are propagated by division during late winter, when growth is less active. The divisions are potted immediately. They may also be propagated by division of the rhizomes. They should be cut in sections about two inches long, and buried in a flat filled with a mixture of one-half leaf-mold and one-half sand. They are placed in a temperature of 80° until the young leaves appear, when they may be put into three-inch pots.

616. Culture. — Aspidistra is one of the easiest plants to grow. It is used extensively by commercial florists to rent for decoration, because it will stand very unfavorable conditions. It makes a good porch plant for summer, and will grow well in dark halls in dwelling houses. The leaves can be readily cleaned. It should be given an abundance of water, and there may be water in the jardinière in which the plant is placed. This will be beneficial, provided it is changed frequently.

617. Cordylines, botanical classification. — Order, Liliaceæ; genus, Cordyline (*club-like*, referring to fleshy roots), closely related to dracænas. The principal species: *australis*, known to the trade as *Dracæna indivisa*; *terminalis*, known as *Dracæna terminalis*.

618. Cordylines, botanical characters. — The chief difference between Cordyline and Dracæna is that there are three ovules in each cell in Cordyline while in Dracæna there is but one. They are cultivated for their ornamental foliage, which is in various shades of green, often beautifully variegated with red, white and yellow. The same general cultural directions are given for cordylines and dracænas. The flowers are small and insignificant.

Habitat. — New Zealand and East Indies.

619. Propagation. — *Cordyline australis* is easily propagated from seeds. They are sown in February in rather sandy soil, and kept in a temperature of about 65°. They germinate easily and the seedlings make a rapid growth.

The broad-leaved sections are propagated by cutting the ripened stems, from which the leaves have been removed, into pieces from two to four inches long. These are laid either in very light soil, or in sand in the propagating bench, where they receive a bottom heat of about 80°. The stems are barely covered with sand or moss. The buds or eyes soon start into growth, and when they have reached a height of three or four inches, they are cut off with a small heel attached, and again placed in the propagating bench until rooted. They are then potted into three-inch pots and kept in a close, moist atmosphere in a temperature of 60° to 65° until they are well established, when they are shifted into larger pots as needed.

620. Culture. — Cordylines may be grown in pots

during the first summer, and should be in six-inch pots by the following September. They lift easily and may be planted out in the garden during the summer. If this is repeated the second year, the growth will be especially strong and vigorous. They are excellent for vases, urns, hanging baskets or window boxes, and large specimens make excellent decorative effects in conservatories.

Plants in the broad-leaved section like a soil mixture of three parts good turfy loam and one part well-rotted cow manure, with considerable sharp sand worked well into it. They should be given a warm, moist atmosphere and partial shade during the summer, but as fall approaches, they should be gradually accustomed to a drier atmosphere and full sunlight, to develop their colors. These plants are inclined to lose their lower leaves and to become unsightly.

621. *Dracænas*, botanical classification. — Order, Liliacæ; genus, *Dracæna* (*dragon*, the dried juice is supposed to resemble dragon's blood); species, *fragrans*, and its varieties; *Lindenii*; *Massangeana*; *Goldiana*; *Sanderiana*; *Godseffiana*. The botanical characters and cultural directions are noted under the broad-leaved section of Cordyline.

622. *Pandanus* or screw pines, botanical classification. — Order, Pandanacæ; genus, *Pandanus* (from the Malayan name); species: *Veitchii*; *utilis*.

623. *Pandanus*, botanical characters. — Screw pines are tropical plants often attaining the size of trees. They have many large, aerial roots, and long, sword-like leaves arranged in a perfectly spiral manner like the threads of a screw. The margin of the leaves is sharply serrate, that is, they are saw-teeth. They rarely produce flowers or fruits in cultivation.

Habitat. — Widely distributed in the tropics, but most common in the Malay Archipelago.

624. Propagation. — The suckers which form about the base are used for propagation. They are removed, the tops cut back and inserted in a cutting bench, being kept on the dry side until a callus forms. They require some bottom heat, and a bell jar should be placed over them to give a moist atmosphere. If there is any evidence of decay, the bell jar should be removed occasionally. A good way to root them is to fill a propagating case partly full of leaf-mold, wet this and place an inverted seven-inch flower pot on the leaf-mold; insert the cutting through the hole in the bottom of the pot, and keep the case closed.

625. Culture. — There are many species of screw pines which are grown in large collections of palm-like plants, but the first two named are of the most importance. *Pandanus utilis* has rich green, shiny leaves and red spines. *Pandanus Veitchii* has attractively variegated leaves. They are very popular for house plants, and are used in the center of fern dishes. A variety of this exhibited at the International Flower Show in New York in 1914 was called *P. Lindenhurst*, and had broader white bands than the type.

Screw pines are easily grown, but require a temperature of 65° to 70°. They like full sunlight, especially in winter, and this is necessary for the growth of *Veitchii*. A low temperature, with water in the axils of the leaves, causes a rotting of the crown. The growth of aërial roots lifts the plant into the air, so that old plants are somewhat unsightly at the base. *Veitchii*, however, forms many suckers about the base, making it less unsightly than *utilis*. The soil for pandanus should be a fairly heavy loam enriched with one-third decomposed cow manure.

626. Smilax and asparagus, botanical classification. — Order, Liliaceæ; genus, *Asparagus*; species: *plumosus*; *Sprengeri*; *medeoloides*.

627. Asparagus and smilax, botanical characters — *Asparagus* and *smilax* belong to the same family as the field asparagus. Both are extensively grown as potted plants, and also in beds for cutting for house decoration and bouquets. The *smilax* is climbing, as is also *Asparagus plumosus*, but the other species are drooping or trailing. *A. Sprengeri* is an excellent basket plant, especially for piazza baskets and window boxes. The flowers are insignificant, but the fruit is often abundant enough to be attractive, being colored red or blue. The so-called foliage is really leaf-like branches, and the flowers and fruits are borne on the ends of these.

Habitat. — South America.

628. Culture. — All species of asparagus are better grown from seed, although old plants may be divided. They rarely make symmetrical, attractive plants. *Smilax* is almost always grown in solid beds and trained to climb over green silkline which is tied to the sash-bars of the houses or to wire supports. The seed is sown in February, in flats of light soil, and covered about one-half inch with a mixture of leaf-mold and sand. It should be kept well-watered and in a temperature of 65°. The seed should germinate in four or five weeks. As soon as well developed, the seedlings should be transplanted to pots. By May first, they should be in three-inch pots. The bed should be at least two feet deep; stones should be put in the bottom to insure excellent drainage, and over them is placed a rich soil of equal parts loam, well-rotted manure and leaf-mold. The plants should be set deeply. When set in July, a crop should be large enough to cut in

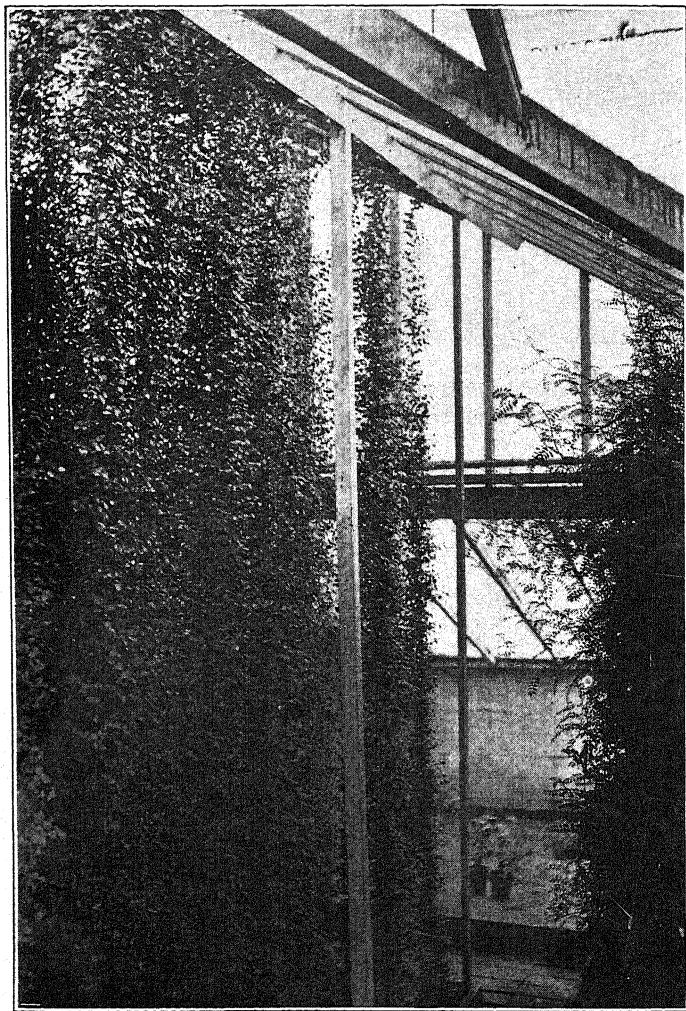


FIG. 44.— Smilax.

October. Beds once established should last three or four years.

Just before cutting in October, water should be withheld to harden the foliage, giving better keeping qualities to the smilax. After cutting, the plants should have a resting period, therefore they should be kept dry for two weeks. Then the bed should be top-dressed with about two inches of stable manure, watered thoroughly, and the strings placed for the next crop. Tying should not be neglected, or the strings will be of little value (Fig. 44).

Asparagus plumosus may be grown the same as smilax. It requires a high house, for the strings are long. Often the best sprays do not develop until the plants have made a considerable height growth. The growth of asparagus is slower than smilax, and the first crop will not be ready to cut before the end of the second year. When once established, it lasts for years, and usually improves for eight or ten years. Both smilax and *Asparagus plumosus* like partial shade, and houses should be shaded, especially during the spring and summer (Fig. 45).

Asparagus Sprengeri is grown in beds, but it is also an excellent potted plant. It is compact and symmetrical in its habit of growth, and is best propagated by seeds sown the same as smilax.

629. Caladiums, botanical classification. — Order, Araceæ; genus, *Caladium* (name of unknown origin), the species of most importance are *bicolor*, *picturatum*; *Humboldtii*. Elephant's ear, or garden caladium, is botanically *Colocasia*.

630. Caladiums, botanical characters. — Caladiums are among the most valuable plants for summer ornamentation of greenhouses. They are herbaceous perennials arising

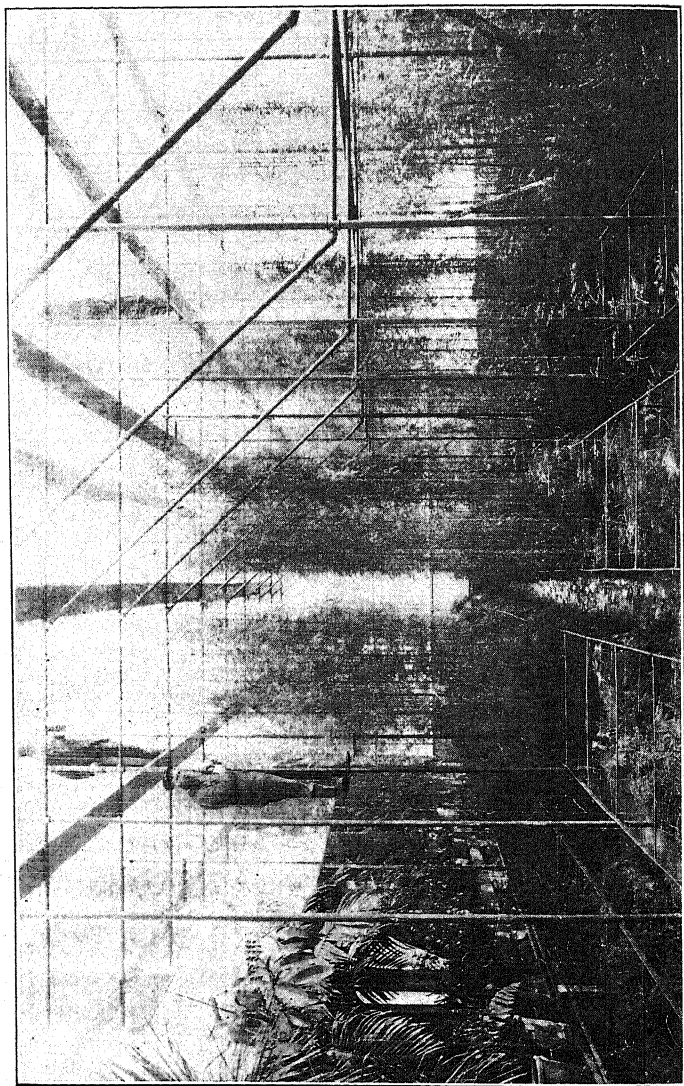


FIG. 45. — *Asparagus plumosus*, as commercially grown.

from large rhizomes, and having remarkably showy leaves and inconspicuous flowers

Habitat. — Tropical America.

631. Propagation. — Caladiums are usually propagated from tubers, the form most frequently purchased.

632. Culture. — As soon as caladiums begin to lose their leaves in the fall, the pots should be laid on their sides, and sufficient water withheld so that no growth takes place. They should not be subjected to a temperature of less than 60°. About March first the tubers should be removed from the soil, arranged closely in boxes of moss, and covered with the same to a depth of about one inch. New roots start from the top of the tuber. They should be kept in an average temperature of 75°. When several roots have started, the tubers should be potted in three- or four-inch pots in a mixture of two-thirds leaf-mold, one-third loam and a little sand. They should be placed near the glass and given considerable shade. They make a rapid growth and soon will need potting into four- or five-inch pots. Never allow them to become pot-bound.

633. Ficus, or rubber plants, botanical classification. — Order, Urticaceæ; genus, *Ficus* (an ancient Latin name); the most important species are: *elastica*, India-rubber tree; *pandurata*, fiddle-leaved rubber tree; *pumila*, creeping fig; *benghalensis*, Banyan tree or small-leaved rubber tree; *Parcellii*, variegated rubber tree.

634. Ficus, botanical characters. — Rubber plants form a group of trees, shrubs or climbing vines, characterized by a milky juice and inconspicuous flowers which are inclosed in a fleshy receptacle. The ornamental-leaved species rarely flower.

Habitat. — Mostly from tropical Asia, Africa and Australia.

635. Propagation. — The most common method of propagating rubber plants is known as "top layering." Old, bushy stock plants are used as parents, and are kept in a night temperature of 60° to 75°. When the young shoots are five or six inches long, a slanting cut is made upward about half way through the stem. A small piece of wood is inserted to keep the cut open. A large handful of finely divided sphagnum moss is placed around the branch to cover the cut, and is made moderately firm with twine or raffia. The moss is kept constantly moist. The roots of the young plant usually appear on the outside of this oval-shaped bunch of moss. The entire branch is then cut off below the moss, and the young plant potted. A small pot is used for this first potting, and the leaves of the plant are tied up, that they may not be injured by handling. The pots are then plunged in sand, where there is some bottom heat.

The rubber plant propagates the best in the spring. Rubber plants may be propagated by cuttings, the same as are other plants. The cuttings are inserted in a mixture of sphagnum moss, loam and leaf-mold, which should be very finely divided, and there should be a bottom heat of 65° to 70°. They are kept in a close, warm, moist atmosphere with only enough ventilation to permit the excess of moisture to escape.

636. Culture. — After the plants are well established in three- or four-inch pots, they will require considerable liquid manure. They adapt themselves to wide ranges of temperature, and will grow in partial shade or in sunlight. The foliage will be a darker green if grown in partial shade. They are often plunged out of doors for the summer, which makes them more hardy, and often causes them to branch more freely than when grown inside.

It is difficult to keep rubber plants symmetrical; they frequently lose their lower leaves and become unsightly. It is possible to keep the growth low by removing the top of the plant when it has reached the desired height. This, however, often makes the top misshapen, and the best looking plants are those which follow their natural habits of growth.

637. Araucarias or Norfolk Island pines, botanical classification. — Order, Pinaceæ; genus, *Araucaria* (a Chilean name); species: *excelsa* and *imbricata*.

638. Araucarias, botanical characters. — Araucarias are very symmetrical, evergreen trees, with stiff, short, many-pointed leaves. Most of the species become large forest trees in their native habitat, but grown under glass, they are low-growing and formal.

Habitat. — Norfolk Island and Chile.

639. Culture. — *Araucaria excelsa* is the most important member of the family, and is imported annually in large numbers from Belgium. There it is propagated and made a leading specialty of many nurseries. Comparatively few are propagated in this country. When used as house plants, they should be placed near the light and thrive best in cool rooms where the temperature is not over 60° at night. They do well in any good potting soil, and should be re-potted frequently enough to prevent becoming badly pot-bound. If there is not sufficient soil and nutriment in the pot, they lose their lower leaves and become unsightly. They require an abundance of water when flowering, but at other times should be kept only moderately moist.

640. Codiaëums or crotons, botanical classification. — Order, Euphorbiaceæ; genus, *Codiaëum*; species, *variegatum*; varieties, many.

641. Codiaëums, botanical characters. — Crotons are somewhat woody plants, having variously lobed, highly colored, thick leaves. The wide range of coloring in the foliage makes them especially attractive.

Habitat. — Malay Peninsula.

642. Commercial importance. — Crotons make excellent plants for window boxes, for vases and for outdoor bedding. They are used quite extensively for the making of fancy baskets for holiday trade.

643. Propagation. — Cuttings of half-ripened wood may be easily rooted at any time from October to June, if they are given a bottom heat of 80°. They are sometimes top-layered as described for propagating rubber plants.

644. Culture. — After crotons are potted, they should not be allowed to become pot-bound. They like a rich, sandy loam, and their foliage colors best when exposed to full sunlight. Crotons require considerable heat, and the night temperature should not go below 60°. The atmosphere should be moist and the plants well syringed on bright days. This will keep the red-spider in check.

CHAPTER XVII

HARDY PLANTS AND THEIR ADAPTATION FOR FORCING

THE constantly increasing demand for flowers has led in recent years, not only to the introduction of new varieties, but to the growing under glass of species never before attempted. Among the species now grown are many hardy plants. They are, for the most part, easily forced, cheaply grown and have a large blooming capacity.

FORCING SHRUBS

645. Species of shrubs which may be forced into bloom under glass. — The species of shrubs best suited for forcing have a compact habit of growth, and are mostly spring or early summer flowering. Among them are the following : —

<i>Azalea nudiflora</i>	. . . . .	Swamp Pink
<i>Azalea calendulacea</i>	. . . . .	Flame Azalea
<i>Azalea indica</i>	. . . . .	Indian Azalea
<i>Calluna vulgaris</i>	. . . . .	Scotch Heather
<i>Cercis canadensis</i>	. . . . .	Red Bud ; Judas Tree
<i>Chenomeles (Cydonia) japonica</i>	. . . . .	Japanese Quince
<i>Cornus florida</i>	. . . . .	Flowering Dogwood
<i>Daphne Cneorum</i>	. . . . .	Garland Flower
<i>Daphne Mezereum</i>	. . . . .	Daphne
<i>Deutzia gracilis</i>	. . . . .	Slender Deutzia
<i>Deutzia Lemoinei</i>	. . . . .	Lemoine's Deutzia
<i>Diervilla florida</i>	. . . . .	Weigelia
<i>Exochorda grandiflora</i>	. . . . .	Pearl Bush

<i>Forsythia viridissima</i>	Golden Bell
<i>Kalmia latifolia</i>	Mountain Laurel
<i>Lonicera tatarica</i>	Tartarian Honeysuckle
<i>Lythrum Salicaria</i>	Purple Loose-Strife
<i>Magnolia stellata</i>	Hall's Magnolia
<i>Philadelphus coronarius</i>	Mock Orange, Syringa
<i>Prunus japonica</i>	Flowering Almond
<i>Prunus Persica</i> var. <i>rosea-pleno</i>	Double Flowering Almond
<i>Prunus tomentosa</i>	Japanese Cherry
<i>Pyrus floribunda</i>	Flowering Crab Apple
<i>Pyrus Halliana</i>	Hall's Flowering Crab Apple
<i>Rhododendron catawbiense</i>	Various Hybrid Rhododendrons

Roses :

Crimson Rambler	
Lady Gay	
Dorothy Perkins	
Tausendschon	
Hiawatha	
Newport Fairy	
Pink Rambler	
Philadelphia Rambler	
Paul Neyron	pink
Frau Karl Druschki	white
Magna Charta	pink
General Jacqueminot	red
<i>Spiræa Thunbergii</i>	Thunberg's Spirea
<i>Spiræa prunifolia</i>	Plum-leaved Spirea
<i>Spiræa Van Houttei</i>	Van Houtte's Spirea

Syringa vulgaris hybrids :

Alphonse Lavalle	light blue, double
Charles X	deep red; single
Frau Bertha Dammann	white, single
Louis van Houtte	rose pink, single
Philemon	deep purple, single
<i>Wistaria chinensis</i>	Chinese Wistaria

Japanese Maples, *Acer palmatum*, are often forced for their attractive foliage characters.

646. Preparation of shrubs for forcing (Fig. 46). — Plants which are to be forced require special preparatory treatment. They should have naturally a compact top and root system. Plants prepared for forcing may be obtained from French,

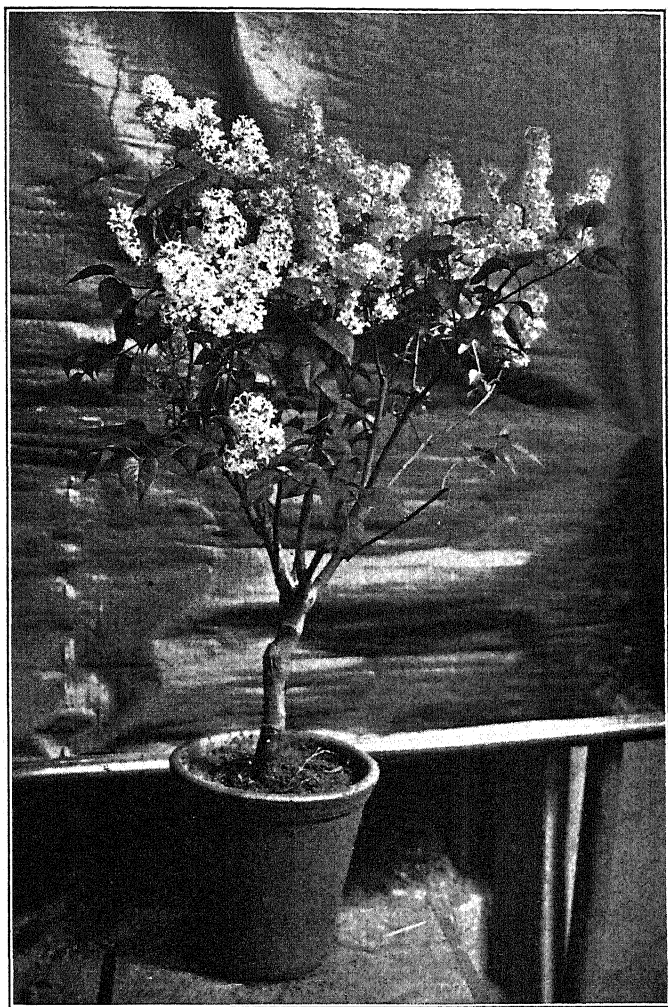


FIG. 46. — A well-forced specimen of lilac (*Syringa*).

Belgian or Dutch nurseries, and in many cases it is cheaper to buy them abroad than to grow them in this country. Certain species, however, it is impossible to buy abroad and such are prepared and grown in American nurseries. To secure the desired compactness, the plants may be grown in the open ground or in pots. The latter is preferred, for many plants have a tendency to grow to stalk and leaves, rather than to produce flower buds, if the root system is given room for an extensive development.

With the exception of rhododendrons and other plants in the family Ericaceæ, shrubs to be forced should be kept closely pruned. This applies both to branches, and to roots. In many strong-growing species, grafting is desirable, as it has a tendency to dwarf them, and to quicken their maturity. When the plants for forcing are grown in nurseries, they are planted far enough apart to give each plant ample room to develop a symmetrical top. They are transplanted every year, and this produces a compact ball of fibrous roots. They force better if they are dug in the spring and put into the pots in which they are to flower. This causes the plants to ripen their wood in a more satisfactory manner, and there is less danger of injury during the forcing process. The pots should be plunged in the soil for the summer months, and if the season is very dry, they should receive occasional waterings.

As soon as the growth of plants ceases in the fall, they should be allowed to ripen their wood gradually. This ceasing to grow will be about September, and no attempt should be made to prolong the growth. Most plants should be stored in a cool cellar or pit, where a temperature of about 35° may be maintained. Compactness in storing is not objectionable as no growth occurs. On bright days, ventilation should be given to prevent an

accumulation of moisture. No watering is necessary if the plants were well watered before they were stored. Too much dampness in the storage cellar will injure the buds and foliage. This is especially true of the evergreens. Snow may cover the pit for a week or more at a time, but will not be injurious if it does not occur frequently. As a rule, plants once forced should be thrown away. Lilacs and azaleas, however, may be put into the nursery, and after cultivation for two years, they will be ready for forcing again. Sometimes the first forcing seems to be an excellent preparation for the second forcing.

647. The resting period. — All hardy plants should have a resting period between blooming seasons. Some plants will come to bloom more quickly than others, for no apparent reason. This must be determined by experiment. Frost does not aid in the resting season. In fact, freezing will often injure the roots of some plants, also the large buds of lilacs and rhododendrons.

648. The season for forcing. — Most hardy plants should not be forced before the middle of December. The longer the days, the better the results. In beginning the forcing, the atmospheric temperature should be about 45°. Syringing should be done twice a day until the buds start. When the plants have commenced to grow, their treatment should be the same as for other greenhouse plants. If attention is given to maintaining a correct temperature, the period of blooming may be accurately determined. Most hardy plants may be forced easily in three months, if they are given a temperature of 45° to 55°. In February and March, plants should bloom in from four to six weeks. Earlier in the winter, more time is required, and the results are more uncertain.

649. The use of ether and chloroform. — Experiments

have shown that ether has the same effect on the protoplasm of plants as it has on animals. There are three stages of rest for a plant. The first is when the plant's greatest growth has been accomplished and it is getting ready to rest; the second is the complete rest; and the third is just as the plant gets ready to start into new growth. The effect of ether is to shorten these periods, especially the second, by making it a more intense resting period. The amount of rest being secured, the plants pass quickly through the third stage, and come into bloom rapidly.

For this method of forcing, the plants are put into a sealed box, and placed in dry sand. The box and the plants should be dry, so that they will not absorb the ether. The temperature should be from 62° to 66°. Directly under the lid of the box, there should be a small bottle into which the ether may be poured. This should be near the lid, as the ether is heavier than air, and the fumes will settle. This treatment should be given in the daytime, as any artificial light will cause the mixed ether and air to explode. Three hundred grams by weight of ether should be used for one cubic meter of air. The plants should be left in the box for forty-eight hours. Sometimes the treatment is repeated in a few days. Pure sulfuric ether is considered the best. Chloroform has not given as satisfactory results.

After this treatment, the plants are placed in a cool house, and receive the usual attention.

Experiments thus far seem to prove that:—

1. The use of ether in late winter is useless, as the plants can then be equally well forced without it.
2. Etherized lilacs force most rapidly; all plants bloom profusely, and the blooms are more perfect, while the foliage is deeper colored.

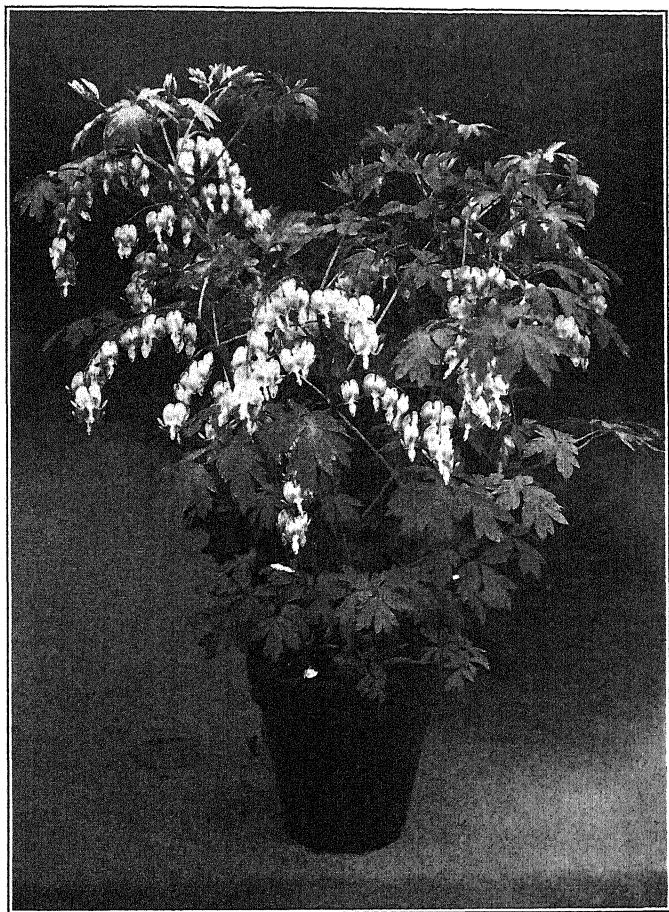


FIG. 47.— The bleeding heart (*Dicentra spectabilis*) makes an excellent plant for forcing.

3. Some varieties, not easily forced otherwise, do very well after etherization.

4. Lilacs, not prepared for forcing, after being etherized, bloom freely.

5. There is less expense connected with forcing plants by using ether, as the plants occupy the houses a shorter time, and force at a lower temperature. They also bring higher prices because of an early market and better quality of bloom.

FORCING HERBACEOUS BIENNIALS AND PERENNIALS

Herbaceous biennals and perennials adapt themselves for forcing even better than do shrubs (Fig 47).

650. List of herbaceous plants which adapt themselves for forcing:—

Achillea Ptarmica var The Pearl	Double White Yarrow
Agapanthus umbellatus	African Lily
Astilbe japonica	Spirea
Convallaria majalis	Lily-of-the-valley
Cypripedium spectabile	Showy Lady's Slipper
Delphinium formosum	Larkspur
Dicentra spectabilis	Bleeding Heart
Digitalis purpurea	Foxglove
Filipendula (Ulmara) palmata	Meadow Queen Spirea
Gaillardia aristata	Blanket Flower
Gypsophila paniculata	Baby's Breath
Hesperis matronalis	Sweet Rocket
Kniphofia Uvaria	Tritoma or Poker Plant
Lilium elegans	Thunbergian Lily
Lilium candidum	Madonna Lily
Lilium speciosum var. rubrum	Spotted Lily
Lythrum Salicaria	Purple Loose-Strife
Myosotis palustris	Forget-me-not
Pentstemon grandiflorus	Orchid-flowered Pentstemon
Platycodon grandiflorum	Balloon Flower
Primula kewensis	English primrose
Primula Polyantha	Polyanthus Primrose
Viola cornuta	Horned Violet
Most bulbs.	

651. Preparation for forcing. — Most biennials and herbaceous perennials for forcing are best propagated by sowing the seed in January as described in Chapter IX. As soon as the seedlings are large enough they are transplanted into flats. They are later planted in rows in a coldframe. If any flower buds develop during the summer, they are removed. This throws the vigor into the root and foliage development. After several severe frosts in the fall, the plants are brought into the houses and planted in raised benches or solid beds. If they are to be grown in pots, it is often best to pot them during the summer, so they may establish a root system before being brought into the house. They are given the same cultural treatment as that required to bring shrubs into bloom.

LILIES-OF-THE-VALLEY AND ASTILBE

652. Lilies-of-the-valley, botanical classification. — Order, Liliaceæ; genus, *Convallaria* (an old Latin name derived from *convallis*, a valley); species, *majalis* (Fig. 48).

653. Lilies-of-the-valley, botanical characters. — The lily-of-the-valley is a hardy, herbaceous plant with radical leaves which spring from an upright root-stock or pip. The flowers are white, small, and tubular, nodding, in a short, radical raceme. They are much grown commercially for their delicate, sweet-scented flowers. The roots are medicinal and are poisonous in large quantities. Lily-of-the-valley is used as a heart stimulant. It is a shade-loving plant.

Habitat. — The natural habitat of the lily-of-the-valley is in the mountains of Virginia and South Carolina, and in the mountainous regions of temperate Europe and Asia.



FIG. 48.— Lily-of-the-valley (*Convallaria majalis*) grown in a pot.

654. Commercial importance. — Lilies-of-the-valley are grown in large quantities to supply the demand of retail stores. They are now standard, all-the-year-round flower crops. Certain specialists produce them, and most general ranges force them to some extent.

655. Outdoor culture. — The lilies-of-the-valley are especially good for planting in partially shaded spots. They like a cool, moist, and rather rich soil. Old beds are liable to run out after a few years, because the root-stocks become crowded. It is better to replant every few years with small, vigorous clumps. They may be bought from nurserymen, and the wholesale price is usually about fifteen dollars a hundred. The foliage of the lilies-of-the-valley makes an excellent ground cover, and is often observed along shady roadsides and in old gardens.

Lilies-of-the-valley may also be grown in hotbeds during the summer. The pips are kept in cold storage until they are to be potted. A hotbed may be prepared in May, and the flowers produced the same as they are grown in green-houses earlier in the year.

656. Indoor culture. — Lilies-of-the-valley, being a short crop, lend themselves readily for forcing, and at any season of the year. The pips are mostly French, German or Holland grown. German pips are considered best for early forcing. The wholesale price varies, but is approximately thirteen dollars a thousand. The pips are received in bundles of twenty-five, and to have them force evenly, it is considered essential to freeze them for a week or two. This may be done by leaving them packed, in some open shed, taking them out for forcing as required. They are often kept in cold storage for summer use. Few new roots are made in forcing.

When lilies-of-the-valley are to be forced in large

quantities, special houses and beds are constructed for them. In a smaller range an ordinary propagating bed with bottom heat may be used. They take no nourishment from the soil, so sand is the best medium in which to force them. The bundles of pips are thawed slowly, the pips separated, and set as evenly as possible in the beds. The sand in the bench should be about six inches deep, and the pips are placed in rows about two inches apart. The pips are placed about three-quarters of an inch apart in the row. A bottom heat of 85° may be given at once, but it is better to start them at 50° and gradually increase the temperature. This gives the flowers better substance than when forced rapidly. A light frame should be built over the sand in which the pips are placed, and this should be covered with heavy paper or cheesecloth to give sufficient shade to draw up the stems.

In early forcing, the leaves are seldom satisfactory. Usually, the flowers mature before the leaves, but the pips may remain in the soil after the flowers are pulled, and the leaves used later for bunching. They should be given an abundance of water during the forcing process, and until the individual flowers begin to show. When the flower buds become well developed, most of the covering should be removed. The flowers should be picked and put in water in a cool place twenty-four hours before they are to be used. This gives them substance and prevents their wilting.

If only a few pips are to be forced, they may be planted in boxes eight inches deep, in the same way as in the propagating beds. They should be kept in a cold frame and frozen solid, then allowed to thaw gradually. When thawed, they should be placed over the heating pipes in the benches, and brought into bloom in the same way as are those in the propagating bed.

Lilies-of-the-valley may be grown in five- or six-inch pots, placing from twelve to twenty pips in each pot. It is well to put sphagnum moss in the bottom of the pot to furnish more moisture, and then fill the pot with sand. These make excellent potted plants for Easter sale. After they are potted, partially shade them and place in a warm temperature, giving them bottom heat if possible.

Clumps are sometimes forced, but are rarely satisfactory, as they do not flower evenly.

657. Astilbes, botanical classification. — Order, Saxifragaceæ; genus, *Astilbe* (name of no special significance); species, seven. Only one is of commercial importance, — *japonica*. There are several varieties; namely, *compacta*, *grandiflora*, *multiflora*, *variegata* and *purpurea*. *Astilbe japonica* is often confused with *Aruncus astilboides*.

658. Astilbes, botanical characters. — Astilbes are medium-sized perennial herbs. They make a dense foliage growth from compact root-stocks, the leaves being divided, shining, dark green and compact. The flower spike rises well above the leaves, making a graceful ornamental plant.

Habitat. — Japan.

659. Commercial importance. — Astilbes are grown in large quantities for late spring sales. They may be had in flower at Easter, but are more in demand for Memorial Day. They make excellent potted plants, and are also sold for cut-flowers.

660. Outdoor culture. — When the plants are through blooming, they may be planted in the shrub border or among the herbaceous perennials, and for spring blooming they are very attractive.

661. Indoor culture. — Imported astilbes are so inexpensive that it is better for the commercial florist to buy, rather than to grow his own plants. As soon as the crowns

are received, they should be stored, separating the roots with a little earth or moss, and placing a little soil over the crown. No amount of freezing does them the slightest harm; however, it is well to cover the boxes or flats in which they are stored with a little straw or litter, and they should have the full benefit of rain or snow to keep the roots from drying out.

It requires from ten to fourteen weeks to bring astilbes into flower after they are potted. Much depends on the earliness of the season at which they are wanted in flower. Ordinary potting soil may be used, and the pot should be sufficiently large to allow for an abundance of water, which they will later need. A temperature of 50° at night suits them best. This may be increased to 60° if necessary, but when grown at a higher temperature, they quickly wilt when cut or used for decoration. From the time the sprays begin to show color, until they are fully developed, every potted astilbe should stand in an inch of water. When sold for window plants or for decoration, astilbes are often disappointing, due simply to lack of sufficient water. Before the full development of the shoots and leaves, they are easily injured by tobacco smoke; hence, they should be covered with paper or syringed thoroughly when fumigation is necessary. Aphids, spider or thrips rarely trouble astilbes.

BULBS FOR FORCING

662. Narcissi, botanical classification.—Order, Amaryllidaceæ; genus, *Narcissus* (from a character in Greek mythology, or from the Greek word for narcotic, in allusion to the narcotic poisoning properties of the plant); species — *Spring blooming: bulbocodium*, meadow-saf-

fron, or hoop-petticoat, *Pseudo-Narcissus*, daffodil or trumpet; *tazetta* — Polyanthus; *poeticus*, poet's or pheasant's eye; *jonquilla* — Jonquil; *triandrus* — cyclamen-flowered; *incomparabilis*, trumpet shorter than in *Pseudo-Narcissus*. *Fall blooming: viridiflorus; elegans; serotinus.*

663. Varieties of Narcissi.—Among the varieties of the *Pseudo-Narcissus* group most generally grown, are Emperor, maximus, moschatus, albicans, Golden Spur, of the single, solid, color forms, Empress, Grandee, *Horsfieldii*, of the single bi-color forms; and Von Sion of double solid colors. In the *tazetta* group, the large flowering "paper whites," Grand Monarque, Grand Soleil d'Or, and Gloriosa, are desirable. The "Chinese Sacred Lily" of this group is also extensively grown. Among the good varieties of jonquils are rugulosus and campernelle. In the *poeticus* group are grandiflorus, King Edward VII, and ornatus; while among the *incomparabilis* section are Sir Watkin and Cynosure, of the single trumpet forms, also Orange Phoenix, and Silver Phoenix, of double forms.

664. Narcissi, botanical characters.—Narcissi are hardy spring-blooming bulbs, with many long, narrow, radical leaves. Each bulb produces one or more flower stems, which bear from one to six flowers. The buds are inclosed in a dry covering or sheath. Each flower is characterized by a tube or crown in the center, which is surrounded by six segments, three exterior and three interior. The colors are mostly white and yellow.

Habitat.—Southwestern Europe.

665. Commercial importance.—Immense quantities of narcissi are imported annually and forced for commercial purposes.

666. Indoor culture.—Bulbs develop roots quickly,

and the *tazetta* (Paper Whites) may be had in flower in ten weeks after planting. They are usually grown in flats, and are brought into the houses as needed throughout the season. Too high a temperature at first will blast the buds. The Von Sion force the slowest, not flowering satisfactorily before February. They require a subdued light, otherwise chlorophyll will develop in the petals, turning them green. Too much nitrogenous fertilizer has a similar effect. The jonquils and Poet's narcissi are especially good for forcing. Perfect flowers depend in a large measure upon the strength of the root system, hence, this should be well developed before the plants are forced.

667. Purchasing. — In purchasing bulbs, it is better, as a rule, to buy the best grade obtainable. This does not necessarily mean the highest priced, for the newer varieties are always expensive. All bulbs should be of good size, firm in substance, and free from disease.

668. Soil and potting. — The bulbs should be potted as soon as received, for bulbs deteriorate rapidly when exposed to the atmosphere. The best soil for bulbs is composed of nearly equal parts of fibrous loam, finely sifted leaf-mold, and thoroughly rotted manure. Enough sand should be added to this mixture to insure perfect drainage. Narcissi are rarely satisfactory when potted singly, but are more attractive in six- or eight-inch pans. This grouping of several in a pan for attractiveness is true of all bulbs. For smaller bulbs, like freesias, grape hyacinths, and crocus, smaller pans may be used. Considerable "crock" or small stones should be placed in the bottom of the pan to facilitate drainage. Some soil should be placed on this, and care taken to have it worked among the pieces of "crock" or stones, so that later, when the plants are watered, the soil will not be

washed from below the bulb. The top of the bulb should be just below the top of the soil after the bulbs are planted, and the soil should be about one-fourth inch from the top of the rim of the pot. This gives plenty of room for water after the bulbs are brought into the house. The amount of soil to be put under the bulbs will, therefore, vary with the length of the bulb and the depth of the pan.

Bulbs should be set lightly on the bottom soil and more soil pressed around them. Avoid pressing into the soil, for if the soil beneath the bulb is too compact, the roots will not penetrate it, and as the root system develops, the bulb will be forced upward and thrown out of the soil.

• **669. Watering, labeling and storing.** — After the bulbs are potted, they should be thoroughly watered. Roots will not form satisfactorily in dry soil. All bulbs should be carefully labeled. After bulbs are potted, they should be stored under conditions which will favor root development and retard the growth of the top. Hence, the soil should be moist, and its temperature somewhat higher than the atmospheric temperature. Most commercial growers have a storage bulb cellar, where the bulbs are available at any season. The windows of the cellar are opened nights when the temperature does not go below 32°, and are closed early in the morning. Freezing does not injure bulbs, provided they are thawed gradually. On small ranges, bulbs are usually stored in coldframes, but it is more difficult to get them out in winter when ready for forcing. If stored in frames, about two inches of coal-ashes are placed in the frames, and the pans or flats are set on them. The ashes keep earthworms away. The pans are then covered with six or eight inches of coal cinders or garden loam, and leaves are placed over this

covering to keep it from freezing. In growing bulbs in the home, they are usually stored in a cool, dark cellar. When bulbs have developed a strong root system, they are ready for forcing.

670. Forcing conditions. — They are brought into a cool greenhouse, and placed under the benches or in some spot in subdued light. A temperature of 50° suits most bulbs. The diminished light draws up the foliage and flower stem, making the blooming period more satisfactory. After the shoots have developed sufficiently, part of the shade is removed, and the foliage assumes a dark green color. The pans are then placed in strong light near the glass, and the temperature increased ten or fifteen degrees. The slower they are forced, the finer and more lasting the blooms will be. During the development of the flower stalk, careful attention should be paid to watering, and at no time should the root system become dry. The tops of the plants should be syringed every bright day until the individual flowers begin to show color, when syringing would injure the blossoms.

671. Outdoor culture. — Narcissi are among the best outdoor bulbs. They are not as satisfactory in formal beds as when planted in a less formal way. They are especially good for naturalizing in sod or along the edges of a body of water. They like a moderately moist soil of medium texture. For formal beds they are planted about five inches deep, and from four to six inches apart. For natural effects, they are planted at about the same depth, but may be any distance apart. For naturalizing, a hole is dug in some unused spot. A little moderately rich soil is put in the bottom, and on this is placed the bulb, care being taken that the top of the bulb is not within four inches of the surface. The hole is then filled with soil.

Narcissi will flower every spring for years, when so prepared, provided the grass is not mown until after the foliage has ripened. Top-dressing every fall with stable manure will prevent them from "running out." When planted in formal beds, seedlings of annuals may be sown among the bulbs. They develop while the bulb foliage is ripening.

672. Hyacinths, botanical classification. — Order, Liliaceæ; genus, *Hyacinthus* (named from a character in Greek mythology); species; *orientalis*—Dutch hyacinth, *orientalis* var. — Roman hyacinth.

673. Hyacinths, botanical characters. — Hyacinths are bulbous plants with only radical leaves and tubular flowers in a raceme or spike. Dutch hyacinths have but one principal flower cluster, while Roman hyacinths may have several. One of these spikes is of better quality than the others, and is sold by florists for cut-flowers. The others are termed seconds, and are used in designs. The Romans flower much earlier than do the Dutch.

Habitat. — Syria, Asia Minor, Greece and Dalmatia.

674. Commercial importance. — Single Roman hyacinths are extensively grown by many florists as a commercial crop. They are generally grown in flats, and sold as cut-flowers, although they make excellent plants for sale when grown in pans. Dutch hyacinths are rarely sold as cut-flowers.

675. Indoor culture. — This is practically the same as that described for narcissi. It is, however, especially important that Dutch hyacinths develop a strong root-system before they are brought into the house for forcing (Fig. 49).

676. Outdoor culture. — Roman hyacinths are seldom

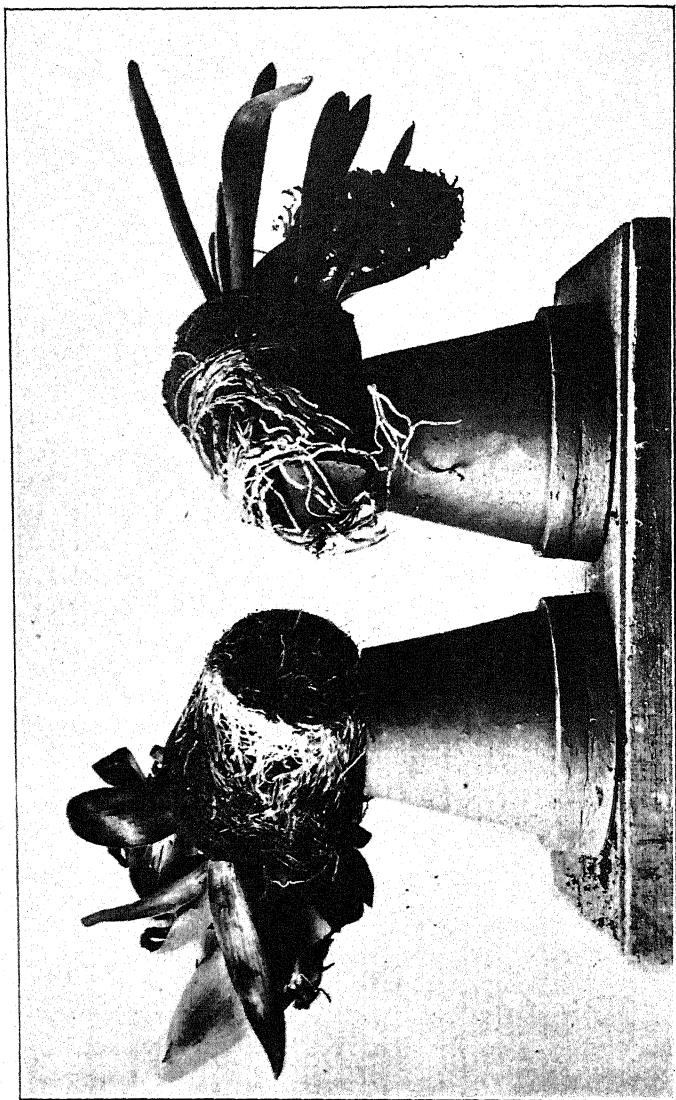


FIG. 49. — All bulbs should develop a strong root-system before they are brought into the house for forcing.

planted out of doors, but the Dutch are usually selected instead.

677. Character of beds suited for hyacinths, and their location. — Hyacinths are, as a rule, more satisfactory when grown in geometrical beds. The flowering habit is formal, and these bulbs therefore lend themselves to planting in round beds or beds of different shapes, better than in irregular borders. While there are hundreds of varieties of hyacinths, the best effects are obtained by planting in solid colors. Contrasting effects are pleasing, but different varieties should be carefully selected, for there is a wide range of time in their season of bloom. The heights should also be the same. Single hyacinths for outdoor planting are more satisfactory than double ones. An open, sunny location should be chosen for beds. Hyacinths are especially pleasing about the bases of statues in parks or about formal fountains. They are less satisfactory on small lawns.

678. Outdoor planting. — In planting hyacinths out of doors, a well-drained, medium light loam should be used. Active fertilizer should never come directly in contact with bulbs, for decay is sure to take place. It is well to manure the beds in which bulbs are to be planted, early in the spring, or some time before the bulbs are put in. A liberal application of bone-meal is beneficial to the growth of the bulbs and is in no way injurious. Although the immature flower-cluster is formed in the bulb, and there is sufficient plant food stored in the bulb tissue to force it into bloom, the flower truss will be larger, and the color more brilliant if a liberal supply of decayed plant food is available. It should be below the bulb, but within reach of the feeding roots. The soil should be well spaded and thoroughly pulverized. It is recom-

mended that for hyacinths and tulips about six inches of the top soil be removed, and the manure and bone spread evenly over and spaded in. After the surface is leveled, a layer of one-fourth inch of sand is added, and the bulbs are set on this. The six inches of top soil is then replaced. Planted in this way, the bulbs develop evenly and come into flower at exactly the same time. It is impossible to get all bulbs in the ground at exactly the same depth in any other way.

For the hyacinth, a depth of five to six inches to the bottom of the bulb is nearly correct. There is a tendency to plant all bulbs too shallow. The bulbs root during the fall and early winter, and if too near the surface, alternate freezing and thawing and a consequent heaving of the soil often cause a breaking of the roots, and inferior flowers are produced.

679. Mulching. — In the early winter and after the ground has become frozen, the bulb beds should be given a light mulch of straw, leaves or strawy manure. This prevents the alternate freezing and thawing, and subsequent injury to the root system. The mulch should not be put on too early, for it tends to warm the soil and the root system continues to develop late in the fall. Flower buds also start sometimes, and later are injured by winter and spring freezing. The mulch need not be over six inches thick, and in the spring should be removed gradually. It should never be left on long enough to injure the flower stalks or to make their development abnormal. This system of mulching applies to all bulbs.

680. Tulips, botanical classification. — Order, Liliaceæ; genus, *Tulipa* (from Oriental name for *turban*); species: *suaveolens*, early tulips; *Gesneriana*, late tulips;

Gesneriana var. *dracontia*, parrot tulips; picotee tulips;
Clusiana also makes a beautiful plant when forced.

681. Varieties of Tulips. — Among the best varieties of tulips for forcing are :

Early Single

Due van Thol, crimson with yellow margin, scarlet, pink,
yellow and white
Queen of the Netherlands, white with pink.
Duchesse de Parma, crimson with yellow margin.
Chrysolora, yellow.
Cottage Maid, pink.
Flamingo, pink.
Vermilion Brilliant, scarlet.
Joost van Vondel, striped, red and white.
Proserpine, deep rose with metallic petals.
Prince of Austria, scarlet.
Pink Beauty, rose pink.

Medium

Thomas Moore, orange.
Yellow Prince, yellow.
White Swan, white.
Rose Gris de Lin, pink.
Pottebakker, scarlet, also white.
Couleur Cardinal, dark crimson.
Keiserkroon, scarlet bordered with orange.

NOTE — Each of these is a good bedding variety for early spring effects.

Doubles for Forcing

Boule de Neige, white
Murillo, pink.
Crown of Gold, yellow.
Imperator Rubrorum, scarlet.
Lord Beaconsfield, pink (one of the best).
Tournesol, yellow; also scarlet, red and yellow.
Rubra Maxima, crimson.
La Candeur, white.

The following varieties are suited for outdoor use:

Late-flowering Tulips

Bouton d'Or, yellow.
 Elegans, crimson with reflex petals.
 Innocence, white.
 Miss Willmott, cream.
 Maiden's Blush, pink
 Summer Beauty, rose flaked with crimson.
 Scarlet Emperor, scarlet with yellow centers.

Parrot Tulips

Admiral of Constantinople, dark red
 Markgraaf von Baden, yellow with scarlet and green strip.
 Cramoise Brilliant, scarlet.

Darwins

Glow, vermilion.
 May Queen, lilac rose.
 Bronze Queen, old gold.
 Gretchen, pink
 Painted Lady, cream white.
 Psyche, old rose edged with white.
 The Sultan, glossy black maroon.

682. Tulips, botanical characters. — Bulbous plants developing stems from three to thirty inches long, bearing a few leaves and surmounted by a single flower. The colors are white, red, yellow and pink, with combinations of these colors.

Habitat. — Oriental countries — Siberia, Asia Minor, China and Japan.

683. Commercial importance. — Tulips are rarely grown singly in pots. Commercially they are usually grown in pans for house decoration, or in flats for cut-flowers.

684. Indoor culture. — Indoor culture of tulips is much the same as the hyacinth. Five or six bulbs are usually placed in a six-inch pan, and are covered to the

tip of the bulbs. They are then watered freely and placed in frames or in a bulb cellar.

After the flowers develop, they should not be placed in direct sunlight, for the petals are delicate and they wilt easily or are burned. For a succession of flowers, the bulbs should be potted early, and a number of pans or flats should be brought into the house about once in two weeks. The early single varieties are best suited for forcing. It is difficult to get satisfactory tulips in flower for Christmas. The Duc van Thols are the earliest.

685. Outdoor culture. — Outdoor tulips are cultivated in much the same way as are hyacinths and narcissi. They lend themselves well to either formal or informal methods of treatment. They are, however, more satisfactory when planted in borders than in formal beds. Pansies, forget-me-nots and English daisies make excellent ground covers when planted among them. All types are attractive, but the varieties of Darwins are especially so. The early varieties are more likely to be injured by late spring frosts. The bulbs should be planted outdoors from September to November, planting them four inches deep to bottom of bulb, and four or five inches apart, while care should be taken to put bulbs at the same depth. Uniform colors should be selected for planting in the same bed. If tulips are planted in too protected a spot, they will start too early in the spring.

686. Crocus, botanical classification. — Order, Iridaceæ; genus, *Crocus* (Greek name for saffron); species, *vernus* and *susianus*. *

687. Crocus, botanical characters. — Crocus are stemless plants with grass-like leaves rising from the ground. They spring from a solid corm. The flowers are showy, white, purple, striped or yellow; funnel-shaped and up-

right with a tube of six segments. The flowers open only in sunshine.

Habitat. — Southern Europe.

688. Indoor culture. — Crocus last but a short time, and so are not especially good for forcing. When they are forced, they are usually grown in a six-inch pan, putting about six corms in a pan. They are then treated as described for hyacinths.

689. Outdoor culture. — Crocus are very satisfactory out of doors, and bloom in early spring almost before the snow has gone. They should be planted in a partially protected spot, in sod land or in formal beds. The crocus is excellent for naturalizing in grass, especially on lawns. A hole should be made in the sod, a little rich soil put in the bottom, and the corm then dropped in. The hole is next filled with the prepared loam. Crocus corms should not be put in sod which is to be lawn-mown early, or where there is constant tramping in early spring.

The new corm forms naturally at the base of the flower-stem, and on top of the old bulb. This brings the corm nearer the surface each year, and after two or three years the corms which have been planted in sod or in out-door beds should be lifted and replanted or they will "run out."

690. Chionodoxas (glory-of-the-snow), **botanical classification.** — Order, Liliaceæ; genus, *Chionodoxa* (Greek meaning "*glory of snow*," referring to the early period of bloom); species, *luciliæ*.

691. Chionodoxas, botanical characters. — *Chionodoxas* are bulbous plants with narrow, grasslike foliage and blue flowers borne on an elongated flower stalk. They are among the best of the early-flowering bulbs, being more showy and attractive than scillas, to which they are closely related. They vary in color from deep blue to white.

They bloom out of doors the last of March or the first of April.

Habitat. — Russia and Asia Minor.

692. Culture. — *Chionodoxas* are well suited for planting in rock gardens, or they may be used as borders for other bulb beds. The soil should be well drained. The bulbs should be planted about two inches deep and rather thickly, placing them about two inches apart. The bulbs should be lifted and replanted every third year. They force readily and need a cool, light location in the greenhouses. For the best effects, they should be thickly planted in small pans.

693. Scillas (squills, bluebells), botanical classification. — Order, Liliaceæ; genus, *Scilla* (an old Greek name alluding to poisonous character of bulbs); species, *sibirica*, *campanulata*.

694. Scillas, botanical characters. — The characters of scillas are similar to those of *chionodoxas*, but the flower-stalks are less upright, the individual flowers larger and lighter blue. They are not quite as hardy and should therefore be planted only in protected places.

Habitat. — Asia Minor and Russia.

The culture is the same as for *chionodoxas*.

695. Grape hyacinths, botanical classification. — Order, Liliaceæ; genus, *Muscari* (Latin name referring to the musky odor of one member of the genus); species, *botryoides*.

696. Grape hyacinths, botanical characters. — Grape hyacinths are very attractive, hardy, spring-blooming bulbs with a flowering habit somewhat like the hyacinths, but the whole character of the plant is more delicate. The individual flowers are small, constricted at the mouth, and have six teeth on the margin of the corolla.

Habitat. — Southern Europe.

697. Outdoor culture. — Grape hyacinths are excellent for planting in a rock garden or along a rustic path. They are also good for naturalizing in grass and for borders of other bulb beds. They should be planted so that the top of the bulb is about two inches below the surface of the soil. Otherwise, they are treated the same as are other bulbs.

698. Indoor culture. — Grape hyacinths produce excellent effects when many bulbs are planted closely together in four- or five-inch pans. They are then put into frames as are other bulbs. After bringing them into the house, they should be started at a low temperature in full light, so that the leaves will develop slowly. Otherwise, they will spindle and become unsightly.

699. Snowdrops, botanical classification. — Order, Amaryllidaceæ; genus, *Galanthus* (Greek for *milk flower*); species; *ivalis*, common snowdrop; *Elwesii*, giant snowdrop.

700. Snowdrops, botanical characters. — Snowdrops are the smallest and daintiest of bulbous plants, blooming often early in March, and having drooping white flowers, each petal having a heart-shaped spot of green.

Habitat. — Europe and Asia.

The culture is the same as for Muscari.

701. Sparaxis, botanical classification. — Order, Iridaceæ; genus, *Sparaxis* (Greek, referring to the cut character of the spathes which distinguishes the genus from *Tritonia*); species, *tricolor*.

702. Sparaxis, botanical characters. — These plants somewhat resemble the freesia, but are less popular. They lack the strong fragrance of freesias.

Habitat. — Cape Colony.

The culture is the same as for Muscari.

703. *Ixias*, botanical classification. — Order, Iridaceæ; genus, *Ixia* (Greek, *bird-lime*, referring to the character of the juice); species, *maculata*.

704. Botanical characters. — Bulbous plants with grass-like foliage and long spikes of showy flowers in early spring. The spike bears from six to twelve flowers, each one and one-half to two inches across. They embrace a wide range of colors, being white, yellow, orange, blue, pink or red. Most forms have a dark brown spot, or “eye,” in the center of the flower. They are excellent for cut-flowers.

Habitat. — Cape of Good Hope.

The culture is the same as for *Muscari*.

CHAPTER XVIII

PLANTS FOR OUTSIDE BEDDING, WINDOW AND VERANDA BOXES

PLANTS for outside planting are much in demand in early spring, and are a source of considerable revenue to flower growers. The plants are grown principally for their ornamental effects, but many furnish cut-flowers as well. They are sold by flower dealers, and supply the demand at a season when few flowers are produced under glass.

BEDDING PLANTS

705. Plants for early effects. — Among the species of plants adapted for early spring effects are pansies, forget-me-nots, English daisies and silenes. They are grown mostly as hardy annuals. The seed is sown in August, in well-prepared soil in the coldframes. By the last of September, the seedlings are transplanted to well-enriched soil in other coldframes and become well established before freezing weather. As soon as the ground has frozen solidly, they are given a light covering of boards to keep the soil from alternate freezing and thawing. The boards should be kept free from snow, and by the first of April they are removed and glass placed over the plants. This should be covered with mats and shutters on very cold nights, but removed on warm bright days and the plants given an abundance of air throughout the day. If growth does not start quickly, a feeding of

liquid manure or nitrate of soda will be found beneficial. The plants should be strong, vigorous in bloom, and ready for outside bedding by the twentieth of April. They may be used in solid beds, for borders of bulb beds, or for planting among late flowering bulbous plants.

706. Plants propagated by cuttings. — Many kinds of bedding plants do not reach maturity and produce flowers satisfactorily in a single season. Others may produce blooms, but they are less abundant on seedlings than on plants reproduced from cuttings. Among such are ageratums, abutilons, achyranthes (iresines), aloysias, alternantheras (telantheras), antirrhinums, coleus, fuchsias, geraniums, heliotropes, lantanas, double petunias, and named varieties of single petunias, salvias, santolinas and vincas (Fig. 50).

Stock for the above may be obtained in two ways. Soft-wooded cuttings may be taken in early fall and propagated as described in Chapter IX. When well rooted, they are put in small pots and later they are re-potted several times during the year, and as spring approaches, other cuttings may be taken from the plants. When large numbers of cuttings are desired, it is customary for flower growers to lift large plants in the fall. They are cut back severely, potted in four- or five-inch pots and are kept partly dormant during the early winter. About the middle of December they are placed on a sunny bench, more heat and water are given and a large number of stocky shoots will break from each plant. These shoots make fine cuttings in January, and hence a good supply of plants, suitable for spring sale, may be obtained. Most varieties of coleus, however, will not survive fall transplanting, but are best propagated from cuttings taken in the fall.

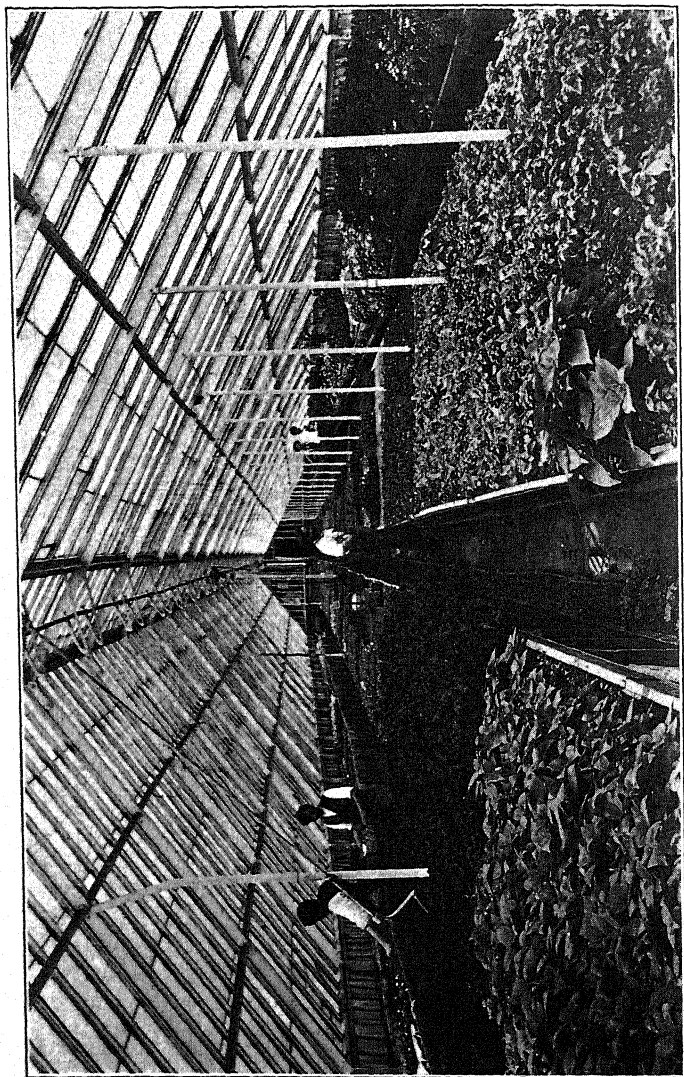


FIG. 50.—A house of young bedding plants which have been propagated by cuttings.

707. Plants which should be propagated from seeds sown early in January. — Several annual plants develop slowly, and it is necessary to start such seeds early in January to get plants ready for early flowering, or for foliage effects. Among them are verbenas, most annual grasses, salvias, ageratums, *Begonia semperflorens*, dusty miller (centaureas) and grevilleas. The seed should be sown the same as outlined in Chapter IX.

708. Genera propagated by seeds sown later in the spring. — The larger part of other bedding plants are started either in flats under glass about the last of March or early in April, sown in cold frames the last of April, or sown directly in the open ground early in May. As a rule, more satisfactory bedding effects are obtained by starting the seedlings in flats in the greenhouse or in frames, and transplanting them once or twice before putting them in their permanent beds. This insures better root systems and stronger dwarf plants. Among the species propagated in this way are asters, antirrhinums, annual delphiniums (larkspurs), alyssums, amaranthus, arctotis, balsams, brachycomes, calendulas, calliopsis, candytufts, annual carnations, celosias, centaureas, clarkias, cleomes, coreopsis, convolvulus, cosmos, dimorphothecas, echinocystis, cobæas, echinops, eschscholtzias, gaillardias, ornamental gourds, gypsophilas, annual sunflowers, lupines, marigolds, four-o'clocks, matthiolas, mignonette, myosotis, nicotiana, nigella, nasturtiums, petunias, Drummond's phlox, poppies, portulacas, pyrethrums, castor oil beans, salpiglossis, scabiosa, schizanthus, stocks, thunbergias and zinnias. Of these species, poppies, mignonette and portulaca do not transplant readily and should be sown where they are to flower.

709. Outdoor plants which are especially good for com-

mercial cut-flowers in summer. — Considerable revenue is derived in some localities by growing various annual plants out of doors for summer sale. Among those easily grown from seed are bachelor's buttons (*Centaurea Cyanus*), snapdragons (*Antirrhinum majus*, and its varieties *nanum* and *grandiflorum*), asters, sweet peas, ten-weeks'-stock and lupines. The propagation and culture of annual plants not already discussed are similar. Therefore, the cultivation of the aster is taken as a type.

710. China asters, botanical classification. — Order Compositæ; genus, *Callistephus*; species, *chinensis*.

711. China asters, botanical characters. — A stout, erect, leafy annual, two or three feet high, corymbosely branched above. The stems are angular and of a purple-brown color. The colors vary considerably, but are mostly in shades of white, purple, pink and red.

Habitat. — The rocky hills of northern China.

712. Commercial importance. — The China aster is of considerable commercial importance. It supplements the carnation during the summer when cut-flowers of many species are lacking. It has excellent keeping qualities and lends itself well to general use. It is probably more extensively grown for cut-flowers than is any other garden species.

713. Culture. — Asters are not difficult to grow. They are not particular as to the type of soil, but require a liberal amount of thoroughly decomposed, organic matter. The early varieties do best on the lighter soils, but the late varieties grow well on a heavy soil. The soil should be thoroughly prepared, for asters are very particular in regard to tillage. The soil in which they are to be placed should be top-dressed in the fall and plowed. In the spring the land should be plowed as early as possible and

thoroughly harrowed. Asters are always propagated by seeds and the best varieties should be selected. The most general practice is to sow the seed in flats or pans in the greenhouse in early spring. As soon as they have germinated, the seedlings are transplanted to flats where they are grown under glass until the season is warm enough to place them in the frames. The plants should be put into the coldframes as early as possible, that they may get well hardened off before being placed in the field. There is then little danger of the plants being chilled.

That the early varieties may make a good growth before hot weather, it is advisable to set the plants in the field as soon as all danger from severe frosts is over. Plants which have been properly hardened will endure slight frosts. The date for planting, therefore, is governed by climatic conditions; usually being about the fifteenth of May. They are ordinarily so placed in the field that they may be cultivated with a wheel hoe. The rows should be about eighteen inches apart and the early varieties may be placed from ten to twelve inches apart in the row, while the later varieties should be from twelve to fourteen inches apart.

TUBEROUS-ROOTED PLANTS SUITABLE FOR OUTDOOR ORNAMENTATION AND FOR CUT-FLOWERS

714. Cannas (Indian shot), **botanical classification.** — Order, Scitamineæ (gingerworts); genus, *Canna* (name of oriental origin, but of no special significance); the most important species are: *indica* (a tall growing species introduced into England about 1540); *iridiflora*; *flaccida*; *Warszewiczii*, *glauca*; *speciosa*; and others.

715. Varieties of Cannas. — Cannas are now classed as

tall varieties and dwarf varieties. Each of these classes is divided into varieties with green foliage, and varieties with bronze foliage. These, in turn, are again divided into varieties which produce self or solid colors, and those which produce spotted, blotched or margined flower. Among the most satisfactory are:—

King Humbert, orange scarlet flowers in large trusses, red bronze foliage, 5 ft.

Italia, red with irregular margin of yellow-green foliage, 4½ ft.

Green Foliage, Red-flowering Varieties

Alphonse Bouvier, 7 ft.

Charles Henderson, 3½ ft.

Philadelphia, 3 ft.

Express, 2½ ft.

Pillar of Fire, 6 to 7 ft.

Green Foliage, Orange and Yellow Varieties

Florence Vaughan, golden yellow, spotted with red, 4 ft.

Buttercup, 3 ft.

Dr. Holtze, 4 ft.

Burbank, 4½ ft.

Austria, 5 ft.

Bronze Foliage, Red-flowering Varieties

Egandale, 4 ft.

Wm. Saunders, 3½ ft ; large trusses.

Green Foliage, Red with Yellow Margin

Mme. Crozy, 4 ft.

Souvenir de Antoine Crozy, 4 ft. Excellent for forcing.

Queen Charlotte, 3 ft.

Gladiator, 5 ft.

Green Foliage, Pink, flowering

Mlle. Berat, 3½ ft.; vigorous.

Hungaria, 3½ ft.

Venus, 4 ft.

Louise, 5 ft.

Green Foliage, Cream-white Flowers

Mont. Blanc, 3½ ft Excellent for borders.

Alsace, 4 ft.

Blanche Wintzer, 3 ft.

716. Cannas, botanical characters. — Cannas are tall, unbranched, large-leaved, herbaceous plants, used for subtropical planting and valuable for outdoor summer effects. The flowers are mostly red or yellow, or combinations of the two colors.

Habitat. — Tropical countries in both hemispheres.

717. History. — The parent of old, garden varieties was *C. Annæi*, raised by M. Annee of France from seeds of *speciosa* crossed with *glauca*. In 1863 a new race appeared as a result of a cross between *iridiflora* and *Warscewiczii*. It was called *Ehemanni*. They were medium in stature, with showy foliage and larger, drooping flowers. This race was grown and experimented with extensively by M. Crozy of France, and many remarkable varieties were originated by him. About 1895, still another race appeared as a result of a cross between *iridiflora* and *flaccida*. They are known as Italian or orchid-flowering cannas, and have large, iris-like flowers and dwarf compact foliage.

718. Commercial importance. — Cannas are grown and sold extensively for outdoor bedding. Their heavy foliage gives them a subtropical character which is very pleasing.

719. Propagation. — Canna rhizomes are usually divided in March, and planted in pots or in sand in the propagating house. The potted ones produce larger, stronger plants. Strong tissue with well-developed buds is selected and all weak rhizomes discarded.

720. Culture. — Cannas should have bottom heat if possible, to develop a strong root system. About the

middle of May, they are taken to the coldframes to harden the tissue before planting in the open ground. Cannas are used to follow bulbs or pansies in outdoor bedding, therefore, they should be well developed when planted. The plants should be set about one foot apart for mass effects, but for general flowering effects they may be from eighteen inches to two feet. Frequently, cannas are planted among shrubs, often for the purpose of making shrub plantings attractive before the shrubs have fully developed.

The flowers should be picked as soon as they wilt, and so prevent the formation of seeds. Seed-production shortens the flowering season, also the withered flowers give the plants an untidy appearance. As soon as the plants are frosted in the fall, they should be dug and left on top of the ground for twenty-four hours if there is no danger of a heavy freeze. The excess of soil should be shaken off and the plants stored in dry sand with the tops down. They may be stored the same way as Irish potatoes. The roots should not become too warm, being kept, if possible, in a temperature of 40° to 45°. New varieties are raised from seed which is usually sown in March. The seed is so hard that it should be soaked in lukewarm water for twenty-four hours, and then the outer covering is cut to allow germination.

721. Dahlias, botanical classification. — Order, Compositæ; genus, *Dahlia* (after Dahl, a Swedish botanist who was a student of Linnæus); species, *rosea* (*variabilis*), *coccinea* and *Juarezii*. There are several different types, as follows: —

(a) *Show*: The show type of dahlia has large, compact flowers, double in center and regular in outline, as if grown in a mold. They are solid, or self-colors or with a darker edge than center. Some good varieties are:

Beauty, white.	Richard of York, lemon.
Bon Ton, garnet.	Kaiser Wilhelm, yellow.
Crimson Globe, crimson.	Madame Moreau, pink.

(b) *Fancy* Fancy dahlias are identical with the show type as to form, but vary in the coloring, the flowers being tipped, or edged lighter than the ground color, and striped or mottled in various ways. They are very variable in color, and in some localities and soils varieties will be highly mottled; in other localities the same varieties will be solid colors. Some good varieties are. —

Admiral Schley, crimson with white stripe.
Lottie Eckford, white, spotted with pink.
Queen Mab, red upper with white.
Gold Medal, yellow upper with red.
Fern-leaved Beauty, crimson with white stripes.

(c) *Pompon*. The pompon type are small, button-like forms, similar to pompon chrysanthemums. They are mostly solid colors. Among desirable varieties are: —

Daybreak, pink.
Fairy Queen, sulfur yellow.
Guiding Star, white.
Indian Chief, crimson.
Snowclad, white.
Vivid, scarlet.

(d) *Cactus*: The cactus type is a very popular one which was introduced in 1872 by J. J. Vanderbing, from Mexico (Dahlia Juarezii). The flowers were exhibited for the first time in England in 1880, and are loose and artistic in form. The "petals" as a rule are long and tubular, the edges rolled or folded backward instead of forward, as are those of the three previous sections. There are single cactus and pompon cactus forms. Some varieties are: —

Uncle Tom, black.
Charm, yellow.
Ward of Honor, pink.
Edith Grenne, white.
F. A. Wellesley, crimson.
Gen. Butler, maroon.

(e) *Decorative*. The decorative type has long, broad, flat and nearly straight petals. They are less regular and formal than

show or fancy types, and are mostly solid colors or have the petals tipped with lighter tints. This class is an intermediate one between the show and cactus types. Varieties are:—

Black Beauty, maroon.
 Mrs. Keith, salmon pink.
 Mrs. Charles Turner, pure yellow.
 William Agnew, red.
 Flora, white.
 Nymphaea, pink.

(f) *Single*: The single form is quite popular, but has not very good keeping qualities. They have but one row of petals, usually eight, and embrace a wide range of colors. They show a great variation of form, from horizontal rays to reflexed or incurved. Varieties are:—

Albine, white.
 Jack, scarlet.
 Twilight, lavender.
 Blackbird, maroon.
 Gaillardia, yellow and red.

(g) *Tom Thumb* is a race of dwarf dahlias producing round, single flowers. They grow from twelve to eighteen inches high, forming dense bushes which flower very freely.

(h) *Collarette*. Collarette dahlias have one row of ray-flowers like the single type, with an additional row of short ray-flowers inside them. These ray-flowers form a frill or collar from which the name of the type comes. The collar is usually differently colored than the outside row of ray-flowers. With few exceptions collarette dahlias are of French origin. Some good varieties are:—

Grayhound	The Peach
Heatherbone	Yellow Prize
Maurice Revoire	Meteor
Jumbo	Exposition De Lyon

Habitat.—Native of high, sandy plains of Mexico, where it was discovered by Humboldt about the year 1815, growing as a single form, five thousand feet above sea level.

722. History.—The dahlia was introduced into Europe about the year 1875 and apparently proved popular in

those countries. Native species are single, the double forms being the result of cultivation.

723. Commercial importance. — The dahlia is quite an important commercial flower. The grower's revenue, however, comes more largely from the sale of tubers in the spring, than from the sale of cut-flowers. Dahlias have a tendency to produce foliage and wood, rather than flowers, and in the early stages of its cultivation it was difficult to get the plants to bloom at all in the northern part of the United States. Breeders have, however, developed a race with early-flowering characters. The show type will usually bloom in ten weeks from the time of planting, and some in even less. The first improvement in dahlia culture was in getting double forms; next, colors were improved, and the stems on individual flowers were lengthened and made stronger.

724. Propagation. — Dahlias may be propagated from cuttings or from seed. The clumps are potted in February. When the shoots have made the third or fourth pair of leaves, the cuttings are made and inserted in sand. The cut should be made through the node, and the cuttings kept in a temperature of about 55° to 60°, while the temperature of the sand is usually from five to ten degrees higher. As soon as the roots are well started, the cuttings may be potted. Young plants should be kept close to the glass, to prevent spindling. Dahlia seed sown in March has given the most satisfactory results.

725. Culture. — Select a rich, deep soil of medium texture and well drained. Heavy clay soils should be avoided. The soil should be plowed or spaded to a depth of fourteen or eighteen inches to make it fine and mellow. Lay the tubers flat, planting them from six to eight inches deep.

Cactus, decorative, show, fancy, single and collarette

727. Varieties. — Each year new varieties are produced, which far outshadow those before known, either in novelty of color, substance, form or prolificacy. Among the present standard varieties are: —

America, pink.
Augusta, pure white, blue anthers.
Baron Hulot, violet.
Blanche, white, slightly flecked with rose.
Canary Bird, yellow.
Empress of India, dark maroon.
Europa, white.
Glory, ruffled, cream yellow.
Golden King, yellow.
Halley, salmon pink.
Independence, red.
Mrs. Frank Pendleton, pink, blotched purple.
Mrs. Francis King, salmon scarlet.
Myrtle, pink.
Niagara, cream white.
Peace, white, lavender dashes in throat.
Primulinus seedlings, yellow, hooded.
Rochester White, white.
Taconic, pink.
Tracy's Dawn, pink.

728. Gladiolus, botanical characters. — A six-parted perianth, usually readily divisible into an upper and a lower segment. The lower segments of the species employed in hybridization all possess some kind of marking, blotch, penciling, dotting, or a pure white throat. The essential organs comprise three stamens, one pistil, the stigma of which is three-branched. Each flower is surrounded by two spathe valves, and the flowers are arranged upon a spike bearing from three to thirty blooms. The leaves are rather prominently ribbed, and by sheathing each other at their bases, form a flat growth in one plane.

Habitat. — Most of the species are from South Africa,

a few are indigenous to Europe, and one comes from Constantinople.

729. Propagation. — The gladiolus is propagated: (1) By seeds. By this method, new varieties are attained, but the standard varieties, being hybrids, do not come true when started from seed. (2) By cormels, or "spawn" (the small, hard-shelled little cormels borne upon the old ones). These, if planted during the spring following the season in which they were produced, will bloom one or two years later, or usually one year sooner than from seed. (3) By the annual renewal of corms, of which there are from one to six, produced above the old corm each year.

730. Culture. — The best soil for the gladiolus is a medium loam. The gladiolus appreciates good fertilization, but seems sensitive to any manure in contact with the bulbs. Manure is, however, good if applied in the autumn previous to planting. The best fertilizer for general use is one that would be called a potato fertilizer, being one rich in potash and phosphoric acid, both chemicals being useful in the proper formation of good bulbs. Bone-meal is also extensively used. Liquid manure, when the buds are forming, seems beneficial.

Most varieties of gladiolus are not hardy, except some varieties of *Lemoinei*, and even these require protection in New York State. Planting should be deferred until all danger of frost is past; and a well-planned succession in planting is advisable. The depth to plant is determined by the character of the soil. In the lightest soil, seven or eight inches is not too deep; but in a heavy clay, four or five inches would be a sufficient depth. There are two reasons why the corms should be planted as deep as the character of the soil will permit: first, the gladiolus

is moisture-loving, and in deep planting, its roots are in the cooler, moist soil ; secondly, the soil acts as a support, no other support being necessary ordinarily. Commercially, the corms are usually planted in rows, often two rows, about six inches apart, in the furrow. If the corms are over one inch in diameter, they are placed right side up ; if less than one inch, they are scattered promiscuously.

Upon the approach of frost, the corms are dug, and the tops left on the corms. They are then stored in an airy place to dry thoroughly. After several weeks, the last year's exhausted corms and the old stems may be removed and the stock cleaned. The best storage temperature is from 40° to 45°, and in a rather dry atmosphere. If the corms become heated, they dry, and this causes them to start prematurely. If too humid, the corms rot or start growth. A shallow tray three or four inches deep insures the corms against heating.

Each year finds new uses for the gladiolus, which now holds first place among the summer blooming corms: first, because of the great range of color ; secondly, because of wonderful keeping qualities, each spike keeping over a week ; thirdly, because of their ease of culture, primarily the same as that for potatoes ; and fourthly, by the proper choice of established varieties, they can be commended because of their cheapness. This flower is extensively utilized for all kinds of decorative work. Large vases or baskets of this stately flower fill a place quite distinct from any other flower.

As a garden subject, the gladiolus is unexcelled for furnishing a long season of bloom, extending from mid-July until frosts, either in a bed, in which case the plants should be very close, or in clumps in the herbaceous border.

WINDOW- AND PIAZZA-GARDENING

There is a growing demand for plants which will grow in limited areas. It may be in window-boxes, veranda-boxes or in hanging-baskets for indoor or outdoor use. Fortunately, there are certain species which are well adapted for just this purpose. The soil should be carefully prepared, for the root systems, being confined in limited areas, should have an abundance of plant food in easily available forms. Careful attention should be given to the watering of boxes or baskets, for plants so grown demand much water, and are easily injured by neglect.

731. Plants suited for outside window-boxes.**A. Winter.****a. Center plants : —**Box (*Buxus sempervirens*).

Dwarf forms of Thuja or Retinispora.

Irish juniper (*Juniperus communis* var. *hibernica*).Swedish juniper (*Juniperus communis* var. *suecica*).Hemlock (*Tsuga canadensis*).Low-growing white pines (*Pinus Strobus*).**b. Vines.**English Ivy (*Hedera helix*).Trailing Evonymus (*Evonymus radicans*).**B. Summer.****a. Tall-growing upright plants : —****1. Flowering :**

Geraniums.

Petunias.

Begonias.

Stevia.

Cannas.

Lantanas.

Impatiens.

Swainsona.

Marguerites.

Salvias.

Hydrangeas.

2. Foliage :
 - Palms.
 - Ferns.
 - Aspidistra.
 - Dracæna (*Cordylone australis*).
 - Cordylone* (*Dracæna*) *terminalis*.
 - Umbrella Palms (*Cyperus alternifolius*).
 - Achyranthes (*Iresine*).
 - Coleus.
 - Crotons.
 - Fancy-leaved Caladium.
- b. Low-growing plants.
 1. Flowering :
 - Pansies.
 - Forget-me-nots.
 - Cigar plants (*Cuphea ignea*).
 - Primula malacoides*.
 - Primula obconica*.
 - Bellis perennis*.
 - Phlox Drummondii*.
 2. Foliage :
 - Peperomia.
 - Rex Begonias.
 - Alternanthera (*Telanthera*).
 - Ferns, various varieties.
 - Mme. Sallerei Geraniums.
- c. Short, drooping or half erect (for edging the boxes) : —
 - Lobelia Erinus*.
 - Othonna capensis*.
 - Alyssum maritimum* var. Tom Thumb.
 - Fuchsia procumbens*.
 - Verbenas.
 - Ivy Geraniums.
 - Variegated Grass (*Oplismenus Burmannii*).
 - Abutilon megapotaamicum* var. *variegatum*.
 - Solanum jasminoides*.
 - Dwarf nasturtium.
- d. Long, drooping vines (for hanging over sides) : —
 - English Ivy.
 - Trailing Evonymus (*Evonymus radicans*).
 - Trailing Vinca (*Vinca major*).
 - Tall Nasturtiums.
 - Japanese Ivy (*Parthenocissus tricuspidata*).
 - German Ivy (*Senecio scandens*).

Cobæa Vine (*Cobæa scandens*).

Manettia Vine (*Manettia bicolor*).

Canarybird Vine (*Tropæolum peregrinum*).

Asparagus Sprengeri

Wandering Jew (*Tradescantia fluminensis*).

e. Climbing vines for posts:

Tall nasturtiums.

Japanese Ivy (*Parthenocissus tricuspidata*).

German Ivy (*Senecio scandens*).

Cobæa Vine (*Cobæa scandens*).

Manettia Vine (*Manettia bicolor*).

Canarybird Vine (*Tropæolum peregrinum*).

Madeira Vine (*Boussingaultia basellordes*).

732. Plants suited for inside window-boxes.

a. Tall-growing, upright plants:—

1. Flowering:

Geraniums.

Begonias.

Impatiens.

Swansons.

Marguerites.

Salvias.

Schizanthus.

2. Foliage:

Palms.

Ferns.

Aspidistra.

Cordyline indivisa.

Cordyline terminalis.

Rubber Plants.

Crotons.

Coleus.

Achyranthes.

b. Low-growing plants:—

1. Flowering:

Cigar Plant (*Cuphea ignea*).

Primulas, all species.

Cyclamen.

Freesias.

All bulbs, such as Narcissi, Hyacinths, Tulips, and the like.

- 2. Foliage ·
 - Peperomia.
 - Alternanthera (*Telanthera*).
 - Ferns, various varieties.
 - Mme. Salleroi Geraniums.
- c. Short, drooping or half erect : —
 - Abutilon megapotamicum*, variety *variegatum*
 - Lobelia Erinus*.
 - Othonna capensis*.
 - Sweet alyssum.
 - Fuchsia procumbens*.
 - Ivy Geraniums.
 - Variegated Grass (*Oplismenus Burmanni*).
 - Solanum jasminoides*.
 - Convolvulus mauritanicus*.
- d. Long, drooping vines · —
 - Trailing vinca (*Vinca major*).
 - German Ivy (*Senecio scandens*).
 - Manettia Vine (*Manettia bicolor*).
 - Asparagus Sprengeri*
 - Wandering Jew (*Tradescantia fluminensis*).
- e. Climbing vines for inside windows —
 - English Ivy (*Hedera helix*).
 - German Ivy (*Senecio scandens*).
 - Manettia Vine (*Manettia bicolor*).
 - Asparagus plumosus*.
 - Smilax.

CHAPTER XIX

PACKING AND SHIPPING PLANTS AND FLOWERS

WITH the increased output of plants and flowers from wholesale ranges, the packing and shipping have become an art. In a large number of instances a firm's reputation for fine produce is strengthened by the careful manner in which it is packed for shipment and the consequent freshness of the plants when received. In the earlier days, any box, no matter how old or soiled, was considered good enough for shipping flowers and plants. Comparatively new, light, wooden or pasteboard boxes are essential for a good shipping trade.

733. Long-distance shipments. — While it is true that long-distance shipments from eastern growers to central and western retailers are less frequent than in former years, there is still considerable plant material shipped throughout the country. The writer recently witnessed the unpacking of a long-distance shipment of plants, and was impressed by the care and thoroughness with which the packing had been done. Hardly a leaf or blossom was injured, and the plants appeared as fresh as if they had just come from the greenhouses.

Palms, dracænas, araucarias, azaleas, rhododendrons and many other species of plants sold in the United States are propagated extensively in Germany, Holland, Belgium, France and other foreign countries. They are

grown abroad, largely because the low cost of labor there makes it impracticable for the American flower-grower to compete in their production. The art of packing has been mastered to a remarkable degree by foreign plant producers, and American gardeners can learn much from them. Recently, experiments have been tried in shipping cut orchids from England. They have reached this country in almost perfect condition and proved to have good keeping qualities. Shipments of cut sprays of lilacs were recently imported from Holland, and arrived in excellent condition after having been nearly two weeks in transportation. Within recent years orchid importations have arrived in very good condition, and there has been a comparatively low percentage of loss.

734. Shipping rooms, their location and equipment. —

On every range where many plants are packed for shipment, there should be a convenient and well-equipped shipping-room. It should be heated sufficiently to prevent any chilling of the plants during the packing process. In ranges where shipments of plants and cut-flowers are large, there are shipping rooms for each. Each room is under the supervision of an expert, who is assisted by a well-trained corps. Shipping-rooms are generally busy places, especially during a holiday season.

In the plant-shipping room, convenient benches are so arranged that the workmen can wrap the plants easily before they are packed. There are racks for crating material of various dimensions, and all the conveniences which make rapid and effective work possible. Material sufficient for any emergency should be always at hand, that the workmen may not be handicapped during a rush season. In addition to boxes and crating materials, there should be readily available an abundance of wrapping

paper, excelsior, string, nails, hammers and knives. Each should be in its proper place in the packing shed, that valuable time may not be wasted.

The shipping-room used for packing cut-flowers should be located near the cold-storage rooms. There should be no time lost in traveling after flowers for packing. The cold-storage rooms should also be centrally located, so there is little congestion in getting to them during a rush season. Most flower shipping-rooms are equipped with comparatively low benches on which the boxes are placed to be filled. If pasteboard boxes are used, they are usually stored within easy reach, underneath the benches. Where roses are packed extensively for shipments, a sorting and grading table is conveniently near the packing table. The roses, after being sorted and graded, are laid on papers with the buds together, in groups of twelve, then lifted carefully and packed immediately. Frequently, there are small rooms adjacent to the main shipping-room, where expert helpers bunch lilies-of-the-valley, violets and sweet peas. In many instances, this work is done by women. The business office usually adjoins the shipping room, so that orders may be quickly placed and shipments registered.

Most wholesale plant establishments have an up-to-date carpenter's shop, where all boxes and crating materials are prepared. Expert carpenters are here employed. This shop is equipped with saws, planes and all the appurtenances which make rapid work possible. Frequently carts, sleds and other implements used about the range are manufactured by the carpenters during dull shipping seasons, or they may be employed in making repairs on the superstructures of the greenhouses.

735. Selection of material for filling orders. — In

selecting material for shipping, it should be remembered that the reputation of the firm is at stake. Few buyers have time to select their stock of foliage and flowering plants. The selection of cut-flower material must also be left to the honesty of the shipper. Only matured plants of first quality should be selected. Small plants of inferior quality may later develop into first quality material. Cut-flowers which have been recently cut should always be selected, rather than material which has been in cold storage for a considerable period. Mistakes in filling orders should never occur. In large establishments, experienced men fill all the orders and when correctly placed in the packing room, their responsibility ends.

Plants shipped during the summer require, of course, less protection than in winter, but it is necessary to guard against the heating of plant-tissue in the crate. This is especially injurious if it occurs in the crown of plants with fine foliage. For summer shipments, open crates are utilized. The plants may be rapped from the pots and the soil and roots packed firmly, the tops being left exposed to the free circulation of air. Thoroughly water the plants before removing them from the pots. The roots will then be supplied with sufficient moisture to offset the amount lost through the foliage, by transpiration, due to drafts or drying winds. Wrapping the soil and roots in newspapers aids in keeping the soil well about the roots and in retaining the moisture.

736. Preparation of flowering plants for packing.— Specimen plants and those whose root-systems are easily injured are best shipped in pots. All plants should be thoroughly watered a few hours before they are packed, then the moisture conditions will be about right for packing and the soil not water-soaked. Flowering plants

are much more difficult to pack than are foliage plants. Azaleas, ericas, Lorraine begonias, cyclamen and prim-roses require special care. Wide spreading plants, like azaleas, are usually shipped in bud. A stake is first placed in the pot, and the outer branches are drawn in to this stake and tied with raffia. They are then covered with tissue paper, which is brought well around the head of the plant and fastened securely, so there will be no danger of the shoots being broken. The whole plant is next wrapped in sheet cotton, covered with newspapers and lastly with manila paper. Lorraine begonias, and those of a similar character, are securely staked and tied before shipping.

737. Size of crate. — An experienced packer can tell at a glance just how large a crate is needed for a given shipment. There are no rules governing this matter. The plants should be packed securely, however, that the cost of transportation may not be increased, but not closely enough to injure the tops.

738. Method of packing. — Flowering plants are shipped in the pots, and are packed upright in the box. A box of the required size is selected and lined with several thicknesses of paper. Upright stakes are placed in each corner, and after the plants are packed securely and covered with wrapping paper, slats are nailed to the side of the uprights and also across the top. This makes a convenient packing case, in which plants will travel long distances without injury. The bottom of the box is usually lined with excelsior or dry moss, and the spaces between the pots are filled with the same material. This keeps the plants firm. After the plants are in place, a cross strip of two inches by one inch material is nailed inside the box to keep the pots in place, so in case the

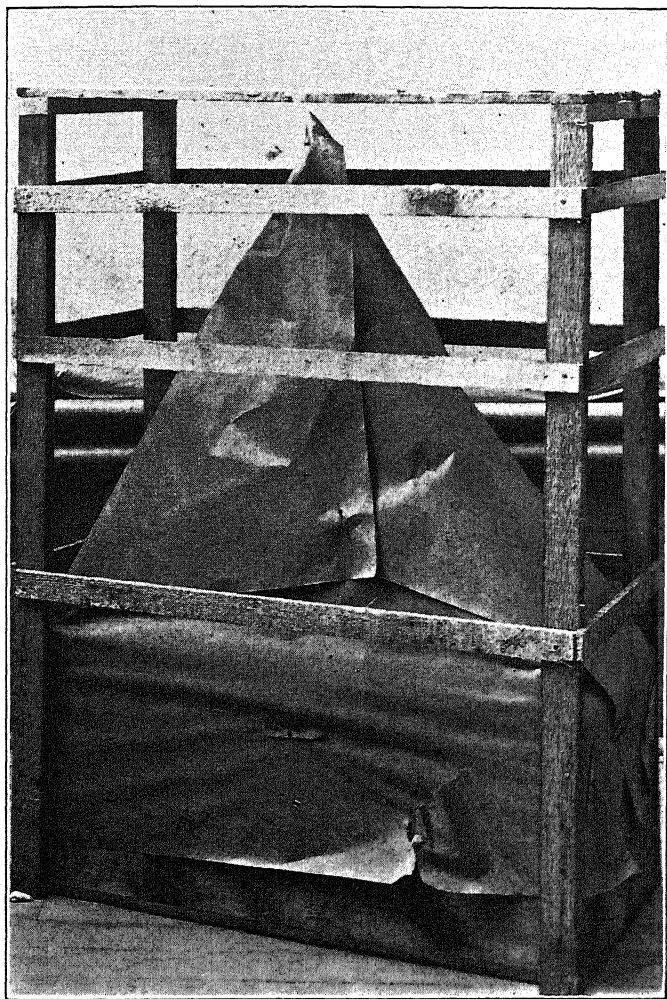


FIG. 51. — Potted plants prepared for shipment.

box is turned on its side, the plants will still remain in position (Fig. 51).

In very cold weather it may be necessary to ship plants in boxes which are entirely closed at the top. In such cases, the boxes should be labeled distinctly, to enable the men handling them in transportation to know which side should be kept upright. Specimen foliage plants, such as palms, ferns, crotons and dracænas, are packed in the way described for flowering plants, except that less attention is paid to protecting the tops with tissue paper or other material. Small plants, such as ferns and asparagus, are usually taken from the pots, their roots wrapped in newspapers, and excelsior tied about them. The papers should be large enough to wrap the entire plant lightly. Usually the plants are wrapped separately, but if quite small, a number may be wrapped in the same paper.

After the shipment is wrapped, a box of the right size is selected, and the bundles of plants are laid with the roots next the end of the box. The next row is reversed so that the papers which protect the tops, overlap. Another row of plants is then placed against the roots of the second row, and this method continued until the bottom of the box is covered. The layer is then covered with coarse manila paper, and cleats are nailed inside the box to prevent the second layer from crushing the first. This is repeated until the box is full. The whole is then covered with dry moss or paper, so the plants will not move about in shipment, and the cover is nailed securely in place.

Large plants, such as palms, may be packed in a similar manner but because of their weight, more care is required to prevent the second layer of plants from crushing the

first. A very essential point in packing is to have the plants so firmly packed that they cannot move in shipment; at the same time, the tops must be protected against injury by over-crowding. In packing, the finished crate should always be light enough to be handled easily during transportation. If the shipment is large, it is much better to have several crates, rather than one heavy one. This insures much more careful handling by express companies.

739. Shipping by freight or express. — As a rule, it is much better to ship plants by express than by freight. This is especially true in cold weather, but even in warm weather, the plants are liable to become dried out if delayed, and often the reduced expense of transportation by freight would be offset by the loss of a shipment.

740. Shipping field-grown plants. — Frequently it is necessary to pack and ship field-grown plants, such as carnations and violets. The plants should be dug in the early morning and placed in a cool shed. This is to reduce the temperature of the plants sufficiently so they will not heat in transportation. In packing carnations, boxes from twenty-four to thirty inches wide, and sufficiently deep to hold the plants without injury to the tops, are considered best.

Before packing carnation plants, a layer of well-moistened sphagnum moss is placed in the bottom of the box. The box is then tilted to an angle of about forty-five degrees and the plants laid firmly in place. The plants are packed securely and a little moss is placed around the roots. The tops, however, are partly exposed so that an abundance of air may reach them, still sufficiently protected to guard against being wilted by the sun or by drafts of air.

A layer of plants is followed by a layer of sphagnum, which covers the roots and is brought well up around the necks. When the plants are in position, they are held firmly in place by a cleat which just fits the box. The cover is then nailed on, and an opening left so that there is a free circulation of air over the tops of the plants. The box is distinctly addressed, and so labeled that the express company will understand that it contains perishable plants, and there should be no delay in shipment. Violets may be shipped in a similar manner.

If possible, a grower should secure his stock plants before they are planted in the field. There is always considerable loss in shipping large plants. Stem rot is very liable to occur, especially if the plants are to be shipped a considerable distance.

741. Shipping bedding-plants. — Bedding-plants, such as geraniums, heliotropes, fuchsias and coleus, may be shipped either in or out of the pots. If sent a considerable distance, or if they are to be held for sale in retail stores, commission houses or auction rooms, it is much safer to ship in pots. On the other hand, the increase in the bulk of the shipment and the value of the pots make it desirable, whenever possible, to remove plants from the pots before shipment. As the pots are removed, the roots are wrapped in newspapers. The packing box is tilted on end at an angle of about forty-five degrees, and the plants are placed closely and firmly in the box.

742. Packing of flowers. — Flowers should be prepared for shipment by placing them in water for several hours, that the tissues may become well filled. Flowers freshly cut and shipped are rarely received in good condition. It is an art to pack flowers so that they will reach their destination as fresh as when packed. It is possible, how-

ever, to ship roses, carnations, orchids and other flowers hundreds of miles, and have them received in excellent condition.

743. Boxes. — As a rule, wooden boxes are superior to pasteboard. Pasteboard boxes are so pliable that, even with the most careful handling, the flowers become more or less bruised. Flowers should never be packed so closely as to crush each other; on the other hand, they should not be packed too loosely. Different species of flowers require different methods of packing. There are also several methods of packing the same species, and growers differ as to which is preferable. Boxes suitable for American Beauty roses would be ill suited for carnations or violets. Each requires a box of a particular size and shape.

744. Roses. — For shipping roses of standard size, the inside measurements of a convenient box are five inches deep, twelve inches wide and five feet long. The ends of the box are made of three-fourths-inch material, and the bottom, sides and top of three-eighths-inch. Such a box is light, convenient to handle, and roses may be packed in it in such a way as to insure their transportation without crushing. The bottom, ends and sides are first lined with several thicknesses of newspaper, and a layer of waxed paper is placed over them. If the roses are of medium size, twenty-five are laid with their buds closely together, on a piece of waxed paper which is about twelve by fifteen inches. A sufficient pad of tissue paper should be placed at the end of the box, so that the first layer of blooms will not be crushed by crowding against the end. The packing box is placed lengthwise in front of the packer, and the first layer is placed with the buds pointing to the packer's left. If ice is used in packing, it



FIG. 52. — A shipment of cut roses.

should be finely cracked and scattered among the foliage. It should never come in contact with the petals. A second layer of roses is then put in place, so that the tips of the buds are just below the base of the buds of the first row. The waxed paper on which the buds are placed separates and protects them from the buds of the first row. Then follows a third row, and so on, until the box is full. The stems at the right are covered with newspapers to prevent slipping. Waxed paper and newspapers are placed over the blooms and the top of the box nailed securely in place. In cold weather it may be necessary to wrap the box in several thicknesses of newspaper (Fig. 52). American Beauty roses are packed in a similar manner, but require boxes somewhat longer and deeper.

745. Carnations. — Carnations are packed in much the same manner as roses, except that the waxed paper between the rows is usually omitted. They are generally shipped in corrugated pasteboard boxes, but there is always the danger of the flowers being crushed. Carnations for exhibition purposes should always be shipped in wooden boxes.

746. Chrysanthemums. — In shipping chrysanthemums, it is especially necessary that the stem tissue be well filled with water before they are packed. The boxes generally used for large single blooms are five and one-half feet long, twenty inches wide and ten inches deep. They are made of one-half inch planed material, and are re-inforced at the corners. Such a box holds from eighteen to twenty-four blooms. The boxes are lined with newspapers and have an inner lining of waxed paper. If the blooms are large, small pads made of excelsior wrapped in newspapers are used to support the necks of the flowers. For smaller flowers, pads of newspaper alone

are used. The flowers are then packed in the same way as roses. To prevent any crowding of the blooms, tissue paper should be freely used.

Water should never come in contact with the petals; therefore they should be covered with oiled paper. If ice is used, it should be scattered among the foliage only. After the flowers are packed, a light strip of wood should be laid firmly across the stems and nailed securely to prevent the flowers from shifting about. Sprays or small-flowered chrysanthemums are shipped in a similar way but in smaller boxes.

747. Violets and other flowers shipped in bunches. — Violets should be shipped in boxes not over six or seven inches deep. Fifty or one hundred flowers are first placed in a bunch, the number being governed by local market demands. Each bunch is wrapped in tissue paper, and they are packed with the stems down.

Sweet peas, lilies-of-the-valley and Roman hyacinths are also bunched before shipping. The bunches are wrapped in tissue paper the same as violets. A pad of tissue paper is placed in the end of the box for the bunches to rest upon, and tissue paper is also freely used between the bunches, to prevent the individual flowers from being crushed. There should be but one layer of bunches in a box.

Flowers from bulbous plants, such as tulips, paper-white narcissi and daffodils, are more difficult to pack than most flowers. They are laid flat in the boxes and require a firm packing, but should be guarded well against crushing.

748. Orchids. — Orchid flowers are difficult to ship without bruising, but their value makes the extra work well worth while. This is especially true of cattleyas. The large, delicate petals should be handled as little as

possible. The boxes are first lined with newspaper, then with waxed paper and lastly with a layer of sheet cotton. The flowers are laid on this, and it is well to fasten the stems to the bottom of the box. When all the flowers are in place, a light covering of sheet cotton may be placed over them and thin cleats of wood nailed inside the box to hold the cotton in place. Waxed papers and newspapers are then laid over the cleats. Packed in this way, the most delicate orchids should travel for long distances.

749. Easter lilies. — Lilies are also difficult to pack. When possible, they should be shipped when about to open. If necessary to ship them in bloom, the box should be carefully lined and each individual flower wrapped in tissue paper or sheet cotton. Sometimes, cotton batting is placed inside the flower to prevent its crushing. Thick pads of excelsior wrapped in newspapers are used underneath the stems near the flowers. Frequently, a light, thin strip of wood is nailed inside the box, and covered with sheet cotton. The necks of the lilies are laid on this and fastened securely. This prevents any crushing which might result from the flowers touching the bottom of the box. Several stems of lilies may be bunched before placing them in the box, and thus economize space.

The most delicate flowers, such as sprays of bouvardia, gardenias and camellias, are usually prepared for shipment by wrapping individual flowers or sprays in waxed paper, then packing all the flowers lightly in a strong box.

In shipping cut-flowers, it is always best to have the boxes tied with strong string or cheap twine. This facilitates handling the boxes and they are more certain to reach their destination promptly. All shipments should be labeled in large type, "Perishable," "Plants," or "Cut-flowers."

750. Bouquets and designs. — Bouquets and designs are usually shipped in strong boxes lined with newspaper and waxed paper. The design should be wired securely to the bottom of the box. Tissue paper and waxed paper are laid over the flowers, and the box cover nailed on. The box should be plainly labeled, that expressmen may know what it contains.

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